GHENT UNIVERSITY

Course Specifications

Valid in the academic year 2025-2026

General Relativity (C004451)

Course size *(nominal values; actual values may depend on programme)*

Credits 6.0 **Study time 180 h**

Course offerings and teaching methods in academic year 2025-2026

A (semester 1)	English	Gent	seminar
			lecture

Lecturers in academic year 2025-2026

Ghosh, Archisman	WE05	lecturer-in-charge

Offered in the following programmes in 2025-2026	crdts	offering
Master of Science in Teaching in Science and Technology(main subject Mathematics)	6	A
Master of Science in Teaching in Science and Technology(main subject Physics and Astronomy)	6	A
Master of Science in Mathematics	6	A
Master of Science in Physics and Astronomy	6	A
Master of Science in Physics and Astronomy	6	A
Exchange Programme in Mathematics (master's level)	6	A
Exchange Programme in Physics and Astronomy (Master's Level)	6	A

Teaching languages

English

Keywords

Einstein's theory of relativity, gravity, black holes, gravitational waves, cosmology

Position of the course

This course gives an introduction to general relativity, a theory proposed by Einstein which serves as our current best description of gravity. An understanding of general relativity is necessary for theoretical physics as well as for astrophysics and cosmology. General relativity is our basis for the understanding of black holes and an expanding universe. The recent discovery of gravitational waves is one of the many tests that this theory has passed over the last 100 years or so.

The emphasis of this course is on an understanding of the foundations of general relativity. This includes development of the necessary mathematical formalism, as well as the connection to physics and the description of observed phenomena. Some of the applications of general relativity are also briefly discussed in this course; they can be followed up in further detail in more specialized courses.

Contents

- revision of the concepts of special relativity
- physical and mathematical foundations of general relativity
- classical tests of general relativity
- the Schwarzschild solution and black holes
- linearization and gravitational waves
- cosmology: general relativity as the basis for the description of an expanding universe

Initial competences

Students are expected to have followed the course "Relativity and Electromagnetism".

Students who want to take this course as an elective but have not followed "Relativity and Electromagnetism" should go over, in advance of this course, the material on special relativity. This would be Chapter 12 from the textbook "Introduction to Electrodynamics" by David J Griffiths or equivalent.

Final competences

1 Students get an understanding of the physical and mathematical foundations of general relativity.
2 Students are able to connect general relativity to topics such as black holes, gravitational waves, and cosmology.

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Seminar, Lecture

Study material

Type: Handouts

Name: General Relativity lecture notes by Daniel Baumann
Indicative price: Free or paid by faculty
Optional: no
Language : English
Available on Ufora : Yes
Online Available : Yes
Additional information: Available online at http://cosmology.amsterdam/general-relativity/

References

We will follow to a large extent lecture notes available online, e.g., the General Relativity lecture notes by Prof. Daniel Baumann for an equivalent course offered at the University of Amsterdam (http://cosmology.amsterdam/general-relativity/). Any complementary material will be available as a pdf via the e-learning platform.

A number of textbooks on general relativity are available, which vary significantly in their content, approach, and manner of presentation. In order to complement the course material, the following references may be useful.

Introductory textbooks:

- **Sean M. Carroll**: *Spacetime and Geometry: An introduction to General Relativity*, Cambridge University Press -- a theoretical introduction built around the lecture notes by the same author available online (https://www.preposterousuniverse.com/grnotes/).
- **James B. Hartle:** *Gravity: an introduction to Einstein's General Relativity*, Cambridge University Press -- discusses experimental tests of gravity to a much greater detail.
- **Bernard F. Schutz**: *A first course in general relativity* (3rd edition), Cambridge University Press (2022) -- goes deeper into the physics of compact objects (such as neutron stars) and contains the most up-to date references to the recent discoveries and results from gravitational waves.

More advanced textbooks:

- **Robert M. Wald**: *General Relativity*, University of Chicago Press -- it offers a geometrical perspective of gravity.
- **Steven Weinberg**: *Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity*, Wiley -- it offers a more field-theoretic approach.

Course content-related study coaching

Assessment moments

end-of-term and continuous assessment

Examination methods in case of periodic assessment during the first examination period

Oral assessment, Written assessment with open-ended questions

Examination methods in case of periodic assessment during the second examination period

Oral assessment, Written assessment with open-ended questions

Examination methods in case of permanent assessment

Presentation, Assignment

Possibilities of retake in case of permanent assessment

examination during the second examination period is possible in modified form

Extra information on the examination methods

Continuous assessment: Homework assignments on basic course material; presentation of a more advanced topic.

End-of-term evaluation: Written exam focussing on theory and exercises (students may thereby use a list of basic formulas - the main goal is to test their insight into the material); oral exam primarily focussing on theory.

Calculation of the examination mark

Non-periodical evaluation -- assignments and presentation (40%)

- 20% Theory
- 20% Exercises

Periodical examination -- end-term exam, written and oral (60%)

- 30% Theory
- 30% Exercises

Students will need to independently pass the non-periodical assessment as well as end-of-term exam in order to pass the course.