

Carleton University Physics Department

PHYS 4804/5804 - Introduction to General Relativity

Winter 2026 Course Outline

Instructor: Prof. Daniel Stolarski (he/him)

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Office: HP3320

Schedule: Monday & Friday, 1:05 P.M. - 2:25 P.M. Please check Carleton Central for location.

Course delivery: The course will consist of synchronous meetings that will follow an in person model where we will gather in our classroom. I will lead a discussion of the course material in a lecture style following the chalk-and-talk. Students are encouraged to ask questions and engage with the material during the lecture. These sessions are intended to be the primary method of course delivery and it is highly recommended that you attend these sessions except in the case of an emergency.

Calendar Description: Special relativity using tensor analysis. Curved spacetime with physics applications which may include the solar system, stars, black holes, and gravitational waves. Introduction to differential geometry and Einstein's field equations.

Prerequisites: PHYS 3802 (Advanced Dynamics) or equivalent, or permission of the Department.

Course webpage: See Brightspace

Teaching Assistant: Cyrus Robertson-Orkish (they/he), cyrusrobertsonorkish@cmail.carleton.ca.

Student Hours: Student hours will be determined during the first week of the semester and announced in class and on brightspace.

Required Textbook: James B. Hartle, "Gravity: An Introduction to Einstein's General Relativity," Addison Wesley, 2003. Approximate cost \$85.

Inclusive teaching statement: Science is for everyone. I am committed to fostering an environment for learning that is inclusive for everyone regardless of gender identity, gender expression, sex, sexual orientation, race, ethnicity, ability, age, class, etc. All students in the class, the instructor, and any guests should be treated with respect during all interactions. It is my hope that our class will support diversity of experience, thought, and perspective. I will continually strive to create inclusive learning environments and would therefore appreciate your support and feedback. I welcome emails or in-person communications to let me know your preferred name or pronoun. Please see the Faculty of Science Equity, Diversity, and Inclusion (EDI) statement.

Mental Health: Taking classes at university can be difficult and stressful. If you are struggling with your mental health, please do not hesitate to reach out. I can direct you to resources that might help. Remember that Carleton also offers an array of mental health and well-being resources, which can be found [here](#).

Statement on AI Use: Artificial Intelligence and generative AI tools have become extremely sophisticated recently. While they can be useful for physics students, they can also interfere in the learning process. In this course, students may use AI tools for clarifying challenging concepts

or to suggest additional reading. Other responsible ways to use AI include summarizing textbook passages, reviewing background math, and generating practice problems. Students should be aware that AI can give incorrect information and should not be relied on.

Use of AI to assist with assignment problems is strictly forbidden and considered academic misconduct. One of the main learning outcomes of this course is to teach you how to solve technically sophisticated problems in general relativity, and these skills can only be developed by solving (sometimes difficult) problems on your own. This AI policy reinforces my teaching philosophy that learning comes from hard work and struggle on problems. Furthermore, the practice acquired by solving problems independently is necessary for success on the exams in this course.

I used ChatGPT 5 to copy edit this course outline.

Assignments and Grading

	PHYS 4804 (undergraduates)	PHYS 5804 (graduate students)
Assignments	40%	35%
Midterm	25%	20%
Final	35%	30%
Project	N/A	15%

Details for each of the components are given here.

Assignments:

Assignments will be posted and submitted on Brightspace. Students can hand write their solutions and scan or photograph them to upload to the website. **Please upload a single pdf file.** In the first part of the course, assignments will be assigned weekly, and in the second part, they will be given every other week.

As noted above, working through problems is an essential part of developing a deep understanding of the subject as this material is heavily math based. **Students are permitted to discuss concepts and strategies related to solving the homework assignments; however, the work handed in must be their own.** Viewing or searching for solutions in any form before your assignment is submitted is forbidden and will be considered academic misconduct. This includes solution manuals, worked problems on the internet, solutions written by other students or course instructors, or solutions written by AI tools.

Late assignments will not be accepted without a legitimate reason, such as illness. Request for extension should be made by email as early as possible.

Students who are having significant difficulties with the material are encouraged to come to student hours. If the scheduled hours do not work, I am also available by appointment. Please email me with sufficient notice as last minute requests will not be accommodated.

Midterm Exam:

There will be an 80-minute, in-class midterm on February 23. The midterm will be open book and open notes. Only paper books and notes are allowed. No electronics are permitted.

In the case of an exam deferral for legitimate reasons, please inform me within 24 hours of the regularly scheduled midterm to arrange a time to write the deferred exam.

Final Exam:

The final exam will be held during the final exam period in April, and will be 3 hours long. As with the midterm, it will be open book and open notes but only paper books and notes are allowed. The final exam will primarily focus on the material from the second half of the course.

In the event that a deferred exam is necessary, that exam will replace only the final exam component of the course mark, and will only be granted if adequate term work has been completed. Inadequate term work constitutes earning less than 15 of the 65 possible term marks for 4804, and 20 of 70 for 5804.

Project (5804 only):

Graduate students will write a report on a topic of their choice in General Relativity that is not covered during lecture. The report should be written towards an audience of your classmates in the course and be a maximum of 5 pages long. Students will also give a 20 minute presentation on the same topic in class on **April 8** and the report is due on the same day. For the presentation, slides (such as powerpoint) are allowed but not required. The report and the presentation carry equal weight for the project mark.

Possible topics include (but are not limited to):

- Solar system tests of GR
- Rotating or charged black holes
- Astrophysical black holes
- Numerical relativity
- de Sitter and anti-de Sitter spacetimes

Please email me your choice of topic by March 2. Topics will be given out on a first-come, first-serve basis if multiple students want to choose the same topic. I am happy to provide references on any of the above topics.

Course Outline

Below is a rough outline of the course, but it may change to fit the pace needed.

Week	Textbook Chapters	Topic Description
Jan 5	Chapters 1, 2	Geometry as Physics.
Jan 12	Chapters 3	Review of Newtonian Physics
Jan 19	Chapters 4,5	Review of special relativity.
Jan 26	Chapter 6, 7	Gravity as Geometry and Curved Spacetime
Feb 2	Chapter 8	Geodesics
Feb 9	Chapter 9	Geometry Outside a Spherical Star
Feb 16	Winter Break	No classes.
Feb 23		Midterm
Feb 27	Chapter 9 (cont)	Geometry Outside a Spherical Star
Mar 2	Chapter 12	Gravitational collapse and black holes
Mar 9	Chapter 16	Gravitational waves
Mar 16	Chapter 20	A little more math
Mar 23	Chapter 21	Curvature and Einstein's Equation
Mar 30	Chapter 21 (cont)	Curvature and Einstein's Equation
Apr 6	Chapter 22	Sources of Curvature
Apr 8		Graduate Student presentations

Note: There is no class on Friday April 3, but there is class on Wednesday April 8.

Statement on Academic Integrity: Students are expected to uphold the values of academic integrity, which include fairness, honesty, trust, and responsibility. Examples of actions that compromise these values include but are not limited to plagiarism, accessing unauthorized sites for assignments or tests, unauthorized collaboration on assignments or exams, and using artificial intelligence tools such as ChatGPT when your assessment instructions say it is not permitted.

Misconduct in scholarly activity will not be tolerated and will result in consequences as outlined in Carleton University's Academic Integrity Policy. A list of standard sanctions in the Faculty of Science can be found [here](#). Additional details about this process can be found on the Faculty of Science Academic Integrity website. Students are expected to familiarize themselves with and abide by Carleton University's Academic Integrity Policy.

Student Rights Responsibilities: Students are expected to act responsibly and engage respectfully with other students and members of the Carleton and the broader community. See the 7 Rights and Responsibilities Policy for details regarding the expectations of non-academic behaviour of students. Those who participate with another student in the commission of an infraction of this Policy will also be held liable for their actions.

Grade Definition: In accordance with the Carleton University Undergraduate Calendar Regulations, the letter grades assigned in this course will have the following percentage equivalents:

A+ = 90-100 A = 85-89 A- = 80-84

B+ = 77-79

B = 73-76

B- = 70-72

C+ = 67-69

C = 63-66

C- = 60-62

D+ = 57-59

D = 53-56

D- = 50-52

F < 50

WDN = Withdrawn from the course

ABS = Student absent from final exam

DEF = Deferred

Academic Accommodations for Students with Disabilities: If you have a documented disability requiring academic accommodations in this course, please contact the Paul Menton Centre for Students with Disabilities (PMC) at 613-520-6608 or pmc@carleton.ca for a formal evaluation or contact your PMC coordinator to send your instructor your Letter of Accommodation at the beginning of the term. You must also contact the PMC no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with your instructor as soon as possible to ensure accommodation arrangements are made. For more details, visit the Paul Menton Centre website.

Addressing Human Rights Concerns: The University and all members of the University community share responsibility for ensuring that the University's educational, work and living environments are free from discrimination and harassment. Should you have concerns about harassment or discrimination relating to your age, ancestry, citizenship, colour, creed (religion), disability, ethnic origin, family status, gender expression, gender identity, marital status, place of origin, race, sex (including pregnancy), or sexual orientation, please contact the Department of Equity and Inclusive Communities at equity@carleton.ca.

Religious Obligations: Please contact me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, please review the Student Guide to Academic Accommodation.

Survivors of Sexual Violence: As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit the Sexual Violence Prevention and Survivor Support website.

For Pregnancy: Please contact me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, please review the Student Guide to Academic Accommodation.

Accommodation for Student Activities: Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, see the Senate Policy on

Accommodation for Student Activities.

Course Copyright: Classroom teaching and learning activities, including lectures, discussions, presentations, etc., by both instructors and students, are copyright protected and remain the intellectual property of their respective author(s). All course materials, including PowerPoint presentations, outlines, and other materials, are also protected by copyright and remain the intellectual property of their respective author(s). Students registered in the course may take notes and make copies of course materials for their own educational use only. Students are not permitted to reproduce or distribute lecture notes and course materials publicly for commercial or non-commercial purposes without express written consent from the copyright holder(s).

Assistance for Students:

- Paul Menton Centre
- Academic Advising Centre (AAC)
- Centre for Student Academic Support (CSAS)
- Math Tutorial Centre
- Science Student Success Centre
- Health and Counselling Services
- Equity and Inclusivity Communities