

# General Relativity Syllabus

## Department of Mathematics and Statistics

### MATH 4650/5650; PHYC 4650/5650 Winter 2025

*Dalhousie University acknowledges that we are in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq People and pays respect to the Indigenous knowledges held by the Mi'kmaq People, and to the wisdom of their Elders past and present. The Mi'kmaq People signed Peace and Friendship Treaties with the Crown, and section 35 of the Constitution Act, 1982 recognizes and affirms Aboriginal and Treaty rights. We are all Treaty people.*

*Dalhousie University also acknowledges the histories, contributions, and legacies of African Nova Scotians, who have been here for over 400 years.*

#### Course Instructor(s)

Name	Email	Office Hours
Dr. Alan Coley	alan.coley@dal.ca	Wednesdays 12:30 – 1:30 Chase 308; Email and Zoom

#### Course Description

A review of differential geometry will be given followed by an introduction to the general theory of relativity. Various topics will be discussed, including linearized theory and gravitational radiation, spherically symmetric metrics and the Schwarzschild solution, gravitational collapse, black holes, and cosmology.

*Course Prerequisites* MATH 3045.03 or permission of the instructor.

*Course Exclusions* PHYC 4650/5650.

#### Student Resources

The MATH/STAT Learning Centre is in the Chase Building, Room 119 and will be operating in-person and remotely. It opens on January 6, 2025 and support is available Monday through Friday from 11:30 AM – 4:30 PM and Monday through Friday evenings from 6:30 PM – 7:30 PM, until April 26, 2025. Register for the Brightspace “course” at <https://www.dal.ca/faculty/science/math-stats/about/learning-centre.html> to access the online support and see the latest schedule.

#### Course Structure

*Course Delivery* This is an in-person course with lectures (they will not be recorded).

*Lectures* take place on Mondays, Wednesdays, and Fridays from 11:30 AM to 12:30 PM in Chase 227.

*Tutorials* through various Zoom Recordings and videos located on Brightspace.

#### Course Materials

Lecture notes and videos will be provided via Brightspace.

## Assessment

*Assignments* There will be **five (5) assignments/projects** over the course of the term. They comprise **60%** of the final mark.

*Tests/quizzes* None.

*Final exam* There will be a final exam held during the exam period (April 9 to 26) worth **40%** of the final mark.

*Other course requirements* None.

Conversion of numerical grades to final letter grades follows the **Dalhousie Grade Scale**

A+ (90-100)	B+ (77-79)	C+ (65-69)	D (50-54)
A (85-89)	B (73-76)	C (60-64)	F (0-49)
A- (80-84)	B- (70-72)	C- (55-59)	

## Course Policies on Missed or Late Academic Requirements

Outline your policies on missed or late academic requirements, including late or missed assignments, labs, tests, or exams. Indicate what students should do if they miss or are late with an assessment (e.g., exam, assignment, lab), and the consequence(s) of missing or being late (e.g., late penalties, alternate evaluation schemes). Indicate if students are expected to use the Student Declaration of Absence form for late or missed requirements during the term, and if so, how many times they may use the form in your course.

## Course Policies related to Academic Integrity

Explain your policy on collaboration (for individual and group assignments or projects) – state explicitly whether students are allowed to work together on assignments. Indicate if and how plagiarism software (e.g., [Original](#)) will be used in the course. **It is recommended that you include a statement about your expectations around generative AI and large language models (e.g., ChatGPT).**

## Learning Objectives

Include a list of knowledge/skills that students are expected to have after completing the course.

## Course Content

- I. Introduction to Differential Geometry (DG)
- II. Introduction to General Applications
- III. Applications in Spherical Symmetry
  - a. Matter Collapse
  - b. Black Holes
  - c. Observations
  - d. Cosmology
- IV. Linearized GR and GW
- V. Other Topics (advanced DG)

# University Policies and Statements

## **Recognition of Mi'kmaq Territory**

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit or e-mail the Indigenous Student Centre at 1321 Edward St or [elders@dal.ca](mailto:elders@dal.ca). Additional information regarding the Indigenous Student Centre can be found at: [https://www.dal.ca/campus\\_life/communities/indigenous.html](https://www.dal.ca/campus_life/communities/indigenous.html)

## **Internationalization**

At Dalhousie, 'thinking and acting globally' enhances the quality and impact of education, supporting learning that is "interdisciplinary, cross-cultural, global in reach, and orientated toward solving problems that extend across national borders." Additional internationalization information can be found at: <https://www.dal.ca/about-dal/internationalization.html>

## **Academic Integrity**

At Dalhousie University, we are guided in all our work by the values of academic integrity: honesty, trust, fairness, responsibility, and respect. As a student, you are required to demonstrate these values in all the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity. Additional academic integrity information can be found at: [https://www.dal.ca/dept/university\\_secretariat/academic-integrity.html](https://www.dal.ca/dept/university_secretariat/academic-integrity.html)

## **Accessibility**

The Student Accessibility Centre is Dalhousie's centre of expertise for matters related to student accessibility and accommodation. If there are aspects of the design, instruction, and/or experiences within this course (online or in-person) that result in barriers to your inclusion, please contact the Student Accessibility Centre ([https://www.dal.ca/campus\\_life/academic-support/accessibility.html](https://www.dal.ca/campus_life/academic-support/accessibility.html)) for all courses offered by Dalhousie with the exception of Truro. For courses offered by the Faculty of Agriculture, please contact the Student Success Centre in Truro (<https://www.dal.ca/about-dal/agricultural-campus/student-success-centre.html>)

## **Conduct in the Classroom – Culture of Respect**

Substantial and constructive dialogue on challenging issues is an important part of academic inquiry and exchange. It requires willingness to listen and tolerance of opposing points of view. Consideration of individual differences and alternative viewpoints is required of all class members, towards each other, towards instructors, and towards guest speakers. While expressions of differing perspectives are welcome and encouraged, the words and language used should remain within acceptable bounds of civility and respect.

## **Diversity and Inclusion – Culture of Respect**

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness (Strategic Priority 5.2). Additional diversity and inclusion information can be found at: <http://www.dal.ca/cultureofrespect.html>

## **Student Code of Conduct**

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner - perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution. The full Code of Student Conduct can be found at: [https://www.dal.ca/dept/university\\_secretariat/policies/student-life/code-of-student-conduct.html](https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html)

## **Fair Dealing Policy**

The Dalhousie University Fair Dealing Policy provides guidance for the limited use of copyright protected material without the risk of infringement and without having to seek the permission of copyright owners. It is intended to provide a balance between the rights of creators and the rights of users at Dalhousie. Additional information regarding the Fair Dealing Policy can be found at: [https://www.dal.ca/dept/university\\_secretariat/policies/academic/fair-dealing-policy.html](https://www.dal.ca/dept/university_secretariat/policies/academic/fair-dealing-policy.html)

## **Originality Checking Software**

The course instructor may use Dalhousie's approved originality checking software and Google to check the originality of any work submitted for credit, in accordance with the Student Submission of Assignments and Use of Originality Checking Software Policy. Students are free, without penalty of grade, to choose an alternative method of attesting to the authenticity of their work and must inform the instructor no later than the last day to add/drop classes of their intent to choose an alternate method. Additional information regarding Originality Checking Software can be found at: <https://www.dal.ca/about/leadership-governance/academic-integrity/faculty-resources/ouriginal-plagiarism-detection.html>

## **Student Use of Course Materials**

Course materials are designed for use as part of this course at Dalhousie University and are the property of the instructor unless otherwise stated. Third party copyrighted materials (such as books, journal articles, music, videos, etc.) have either been licensed for use in this course or fall under an exception or limitation in Canadian Copyright law. Copying this course material for distribution (e.g. uploading to a commercial third-party website) may lead to a violation of Copyright law.