PHYS3807 for Term Winter 2026

Mathematical Physics I

We, the people of the Faculty of Science at Carleton University, acknowledge that our campus is located on the traditional, unceded territories of the Algonquin Anishinabeg people. Miigwetch for your hospitality and stewardship of this territory and the teachings that come from it. We are grateful for this land, the air that we breathe, and the water that sustains us all as well as for the animals, plants and other living beings: these enable us to research, teach, mentor, support, study, and learn. We recognize our responsibility to our natural environment and to reconciliation with Indigenous peoples.

Course Instructor: Prof. Jesse Heilman

How to address me: Professor Heilman

Gender Pronouns: (he/him/his)

Email: Jesse.Heilman@carleton.ca

Note: If you have or question or would like to talk with me, you can send an email, visit me during student hours (see below), or approach me after lecture.

Best Ways to be in Touch: in class, via email, or during student hours

Student Hours: TBA, HP 3314

Office Location: Room 3314, Herzberg Laboratories

Class Location: Please check Carleton Central for the room location.

Class Times: Mon/Wed, 10:05-11:25

Prerequisites: PHYS 2202, MATH 2004, MATH 3705 or permission of the Department

Department/Unit: Physics

Course TAs: TBD (will be announced on Brightspace)

Welcome to PHYS 3807!

THE GOAL OF THIS COURSE IS TO PRESENT MATHEMATICAL METHODS THAT ARE USEFUL IN ANALYSING A VARIETY OF SITUATION THAT ARISE IN THE STUDY OF PHYSICS.

Calendar entry: Boundary Value problems involving curvilinear coordinates; spherical harmonics, Bessel functions, Green's functions. Functions of a complex variable: analytic functions, contour integration, residue calculus.

If you have not previously taken **PHYS 2202, MATH 2004, MATH 3705**, contact Professor Heilman immediately as they are necessary to be successful in this course.

Course delivery: The course will consist of a mix on synchronous and asynchronous activities. Scheduled class time will consist synchronous, in-person meetings where we will discuss the course material in a Chalk and Talk instruction style format with interspersed tutorial style group problem solving. The best way to take advantage of this course delivery relies on exposure of students to the fundamentals of the concepts under discussion prior to the classroom period. Thus, asynchronous reading assignments will be given in advance of each week via the **Perusall** platform. Students will provide topics they wish to cover in more depth at the beginning of the in-person class session and will participate in guiding the discussion of the material. Thus, it is critical that students complete the reading prior to class and come with topics for discussion. The in-person sessions are intended to synthesize the material covered in the asynchronous activities and teach

students to apply concepts and analyze problems. It is highly recommended that you attend these sessions except in the case of an emergency.

Lecture recording: Given the nature of the class delivery, asynchronous recordings of the class periods are not a useful tool, and no recordings will be taken. I will disseminate the challenge problems covered in class via Brightspace.

Topics Covered and Learning Outcomes

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: https://science.carleton.ca/about/edi/

Topics by Week

Week	Topic/Content
1	Ordinary Differential Equations, Classification and Solution Methods
2	Power Series Solutions
3	Partial Differential Equations, Separation of Variables
4	Fourier Analysis
5	Sturm-Liouville Theory
6	Spherically Symmetric Systems
7	Spherically Symmetric Systems
8	Review/Midterm Exam
9	Cylindrically Symmetric Systems
10	Functions of Complex Variables
11	Complex Series
12	Residue Theorem
13	Review

Important dates and deadlines can be found here: https://carleton.ca/registrar/registration/dates/academic-dates/, including class suspension for fall, winter breaks, and statutory holidays.

Course level learning outcomes:

1. **Classify** differential equations and **select** the correct solution strategy.
2. **Evaluate** series expansions of the solutions to differential equations.
3. **Understand** the impact of Boundary Conditions on the solutions to differential equations.
4. **Apply** concepts from linear algebra to the solutions of differential equations.
5. **Extend** the machinery of calculus to functions of complex numbers.
6. **Collaborate** with your peers to improve understanding.

Assessments

Grade Breakdown

COMPONENT	GRADE VALUE
PROBLEM SETS	30%
MIDTERM EXAM	20%
FINAL EXAM	30%
TUTORIAL MINI-LESSON	20%

Problem Sets

Problem sets will be distributed at several times throughout the term and will generally be due 1 week after distribution. They are designed to give you an opportunity to exercise technical and critical thinking skills in an asynchronous environment. Begin thinking about and working on your assignments as they are assigned.

Students are encouraged to discuss concepts and strategies related to solving the problems; however, the work you turn in must be your own. The assignments are a critical part of the course and working through the problems yourself is essential to learn the material. Your homework solutions should be thorough, self-contained, and logical, with all steps explained.

Assignments will be posted on Brightspace. Solutions may be hand-written or type-set so long as they are easily understood and marked. Help us to give you marks by ensuring your work is legible and easy to follow. Sometimes this means rewriting your solutions once you complete the problem the first time so that your logic is easy to follow. Complete the assigned problems and submit a digital copy, as a **single PDF file**, of them on Brightspace before the due date. Ensure that your uploaded assignment is legible and your writing, if you hand wrote the solutions, is dark enough to easily read.

Tutorial Mini-Lesson

During the term, you will have the opportunity to teach the class about a particular part of our curriculum during the tutorial session. These lessons should target roughly 20 minutes of time including questions from the class and can take whatever format you wish. You will work with one of your classmates on the production of these lessons and there will be two lessons during each tutorial session. As such, attendance of the tutorials is mandatory. Your mark for the mini-lessons will be split between the lesson your give and your participation in the other lessons.

During the first week of class, we will assign topics and times for the mini-lessons. A rubric for the lesson will also be circulated during the first week of class.

Examinations

Midterm

There will be a midterm examination scheduled during our regular class time on March 4th. This will be an in-person examination where you will answer the exam prompts in an exam notebook which will be provided to you on the day of the exam. We will discuss the examination in more detail during the term.

Summative Final

There will be a summative final examination which will be scheduled centrally by the university during the winter examination period. This exam will follow the format of the Midterm but will be longer and cover all material that we will explore in the class. You must pass the final exam in order to pass the class.

Late and Missed Work Policies

Late Work

Without a specific accommodation granted by Professor Heilman, late work will not be accepted. Please contact Professor Heilman at least 24 hours prior to a due date if you would like to ask for an accommodation.

Missed Work

Short-term (5 days or less): For extenuating circumstances beyond your control , you should fill out the academic considerations form and send it to Professor Heilman within 24 hours of the passing of a deadline. If you must consistently use this accommodation, then you must make an appointment with Professor Heilman to discuss your situation as below for Long-term accommodation.

Long-term (> 5 days): For longer term accommodations, fill out the longer-term accommodation form and schedule an appointment with Professor Heilman to discuss your situation .

Learning Materials and Other Course Related Resources

Text

MATHEMATICS FOR PHYSICISTS, SUSAN M. LEA

- This text is out of print.
- Used copies can be found.
- Permission of the author to use a PDF of the book has been granted free of charge

Optional Text: Mathematical Methods in Physics, Engineering, and Chemistry, Borden and Luscombe

Academic Accommodations and Regulations

Carleton is committed to providing academic accessibility for all individuals. You may need special arrangements to meet your academic obligations during the term. The accommodation request processes are outlined on the Academic Accommodations website (https://students.carleton.ca/course-outline/).

Statement on Chat GPT/Generative AI usage

As our understanding of the uses of AI and its relationship to student work and academic integrity continue to evolve, students are required to discuss their use of AI in any circumstance not described here with the course instructor to ensure it supports the learning goals for the course.

AI use in this course: Students may use AI tools for basic word processing and formatting functions, including:

- Grammar and spell checking (e.g., Grammarly, Microsoft Word Editor).

- Basic formatting and design suggestions (e.g., Microsoft Word's formatting tools, PowerPoint Design editor).

Documenting AI use: It is not necessary to document the use of AI for the permitted purposes listed above. If you have questions about a specific use of AI that isn't listed above, please consult Professor Heilman.

Why have I adopted this policy? This policy ensures that student voices and ideas are prioritized and authentically represented, maintaining the integrity of the work produced by students while allowing basic support to enhance clarity, correctness, layout, and flow of ideas. The goal of adopting a limited use of AI is to help students develop foundational skills in communication and critical thinking by practicing substantive content creation without relying on AI support.

Limitations: Students may not use AI for developing solutions to homework problems.

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 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.

Student Concerns

If a concern arises regarding this course, **your first point of contact is me**: Email or drop in during student hours and I will do my best to address your concern. If I am unable to address your concern, the next points of contact are (in this order):

Note: You can also bring your concerns to Ombuds services.