University of Victoria
Department of Physics and Astronomy

PHYS342 - Computational Modeling and Analysis

Fall 2026 Syllabus

We acknowledge and respect the Lək̓ʷəŋən (Songhees and Xʷsepsəm/Esquimalt) Peoples on whose territory the university stands, and the Lək̓ʷəŋən and W̱SÁNEĆ Peoples whose historical relationships with the land continue to this day.

Course Information

Section(s): A01

Unit Value: 1.5 Units

Course Schedule:
Lecture - Mondays, Thursdays from 8:30-9:50am
Lab - Thursdays from 2:30-3:50pm

Prerequisites:
PHYS120/130 or PHYS110/111, CSC110 or CSC115, MATH200.
It is strongly encouraged that students have completed PHYS248 prior to taking this course.

Instructor Information

Instructor: Travis Martin

Email: `travismartin@uvic.ca`
Students are expected to include "PHYS342" in the Subject line of their email, and include their name and student ID in the body of the email. Please allow up to 48h to respond to emails before re-inquiring. If you do not receive a response after 48h, please email again.

Office Hours: TBD

In-Term Feedback: Student comments may be sent via email, however it is not possible for all feedback to be considered within the term.

Modality Information

Lectures: This course is taught in a blended modality. Students will be expected to review theory content prior to scheduled classes. Class time will include some instruction but will focus on application and work. Students are expected to have a laptop or other device with which to program.

Accessibility Statement: Accessibility is critically important to ensure that all students can participate to their fullest extent possible. All required course material is available to students in digital format at the start of term. Students with accessibility concerns are encouraged to discuss

these concerns with instructors as soon as possible.

Technology Information

Course Webpage: Brightspace

Other Technologies: This course may use Zoom.
Students are expected to be familiar with Python programming. Students may access a Jupyter programming environment at `https://jhub-astro.uvic.ca/`. Students may opt to use a Python environment on their own computers instead. Due to limited resources on jhub-astro, students are strongly encouraged to use their own computers and a local installation of Python.

Digital Tools Policy: AI use is permitted in this course as a learning and coding support tool, subject to the following rules:

- Students are responsible for all submitted code, explanations, plots, and numerical results.
- Students may use AI for syntax help, debugging, conceptual explanations, code comments, and tests of the coding.
- Students may not submit AI-generated work that they do not understand or cannot explain.
- Students may not use AI to bypass the main task of an assignment by copy-pasting the text of the assignment into an AI and using the result.
- All numerical results must be verified using appropriate checks, which could include tests under varying conditions, limiting cases, analytic comparisons, conservation laws, or time-step convergence.
- Students may not upload another student's work, course materials, or non-public data to an AI system.

Any submitted document is considered the student's own work. Students are expected to be able to explain what their code does, why the numerical method is appropriate, what assumptions it makes, and how the results were checked. Where demonstration of work is required and AI was used, students are expected to include brief descriptions of how the AI was used. For example: "I used AI assistance for: debugging an indexing error in the finite-difference loop; asking for an explanation of solve_ivp arguments; improving comments in my code. I verified the final code by checking time-step convergence and comparing with the analytic solution for the no-drag case."

Some examples of uses of AI assistance and whether they are acceptable in this course:

Use of AI	**Acceptable?**
Asking what an error message means	Yes
Asking for an explanation of Euler's method, RK4, or array indexing	Yes
Asking for help debugging code the student has already written	Yes
Asking for help making a plot clearer	Yes
Asking for test cases or ways to check convergence	Yes
Asking AI to explain a line of code	Yes
Asking AI to complete the whole assignment from the prompt alone	No
Submitting AI-generated code the student does not understand	No
Asking AI to write the report, discussion or explanation of numerical results	No
Using AI to bypass required derivations or explanations	No
Fabricating output, convergence tests, citations, or interpretation	No

Course Schedule

The following is an approximate schedule. Actual class schedule may vary in response to course demands.

Class	**Activity**	**Date**
2-5	Numerical Differential Equations • Finite difference method • Predictor-corrector method • Applications: Projectile motion, heat dissipation	Sept 14-24
6-9	Simulation of Physical Systems • Collisions • Motion & Dynamics • Coordinate Systems • Applications: Particles (gas), Pendulum, Orbits	Sept 28 - Oct 8
10-11	Probability and Statistics • Frequentist vs Bayesian • Histograms • PDFs, CDFs, Hazards • Statistical quantities, e.g. expectation value, variance, covariance • Applications: Radioactivity, Random Events, Traffic Simulation, Particles (gas)	Oct 12-15
12-15	Monte Carlo Methods • Random Number Generation, MLCG • Distributed Random Numbers • Integration • Simulation • Applications: Simulation with Randomness	Oct 19-29
16-17	Hypothesis Testing • Hypotheses, p-value and α • Test Statistics (T, χ^2)	Nov 2-5
18-21	Parameter Estimation & Model Fitting • Least Squares • χ^2 Minimization • Maximum Likelihood	Nov 12-23
22-25	Uncertainty and Confidence Intervals • Propagation • Bootstrap Method	Nov 26 - Dec 7

Course Outcomes

Summary: This course covers computational approaches to solving practical physics problems. The focus is on simulating, applying and comparing theories to data.

Essential Course Components:

- Students must achieve at least 50% in the course project to be eligible to pass the course. Students who receive a grade lower than 50% will be assigned a grade of F for the course, regardless of overall course grade.
- Students must achieve at least 50% in the final exam to be eligible to pass the course. Students who receive a grade lower than 50% will be assigned a grade of F for the course, regardless of overall course grade.

Furthermore, students who complete the required elements of the course, as outlined above, but who earn less than 60% on the class participation portion of the assessments (i.e., miss more than 40% of the scheduled sessions), will be deemed to have missed too much of the course and will be assigned a final grade of "F" regardless of the performance in the rest of the course.

Intended Learning Outcomes: By the end of this course, successful students should be able to...

- Translate physical situations into computational models by identifying relevant assumptions, variables, parameters, governing equations, and limiting cases.
- Implement numerical methods in Python to solve physics problems, including methods for differential equations, simulations of physical systems, Monte Carlo methods, statistical analysis, model fitting, and uncertainty estimation.
- Evaluate the reliability of numerical results by applying checks such as convergence testing, stability analysis, comparison with analytic limiting cases, conservation laws, dimensional analysis, and physical intuition.
- Use probability and statistics to describe, analyze, and interpret numerical and simulated data, including distributions, summary statistics, residuals, uncertainty estimates, and confidence intervals.
- Apply model-fitting and hypothesis-testing methods to compare numerical results with theoretical expectations, experimental data, or alternative models.
- Design, carry out, and refine an open-ended computational physics project, including defining a feasible scope, setting milestones, responding to challenges, and distinguishing core goals from possible extensions.
- Communicate computational work clearly and professionally through organized code, reproducible workflows, labelled visualizations, written explanations, and oral discussion.
- Use computational tools, including AI tools where appropriate, in a responsible and transparent way while retaining ownership of the reasoning, implementation, interpretation, and communication of the work.

Assessments

The weighted average of all components of this course, detailed below, will be used to determine each student's grade. However, if the application of this scheme would result in grades that are

judged by the instructor to be inconsistent with the University's grading descriptions (`https://www.uvic.ca/calendar/undergrad/index.php#/policy/S1AAgoGuV`), then the instructor will assign percentages consistent with them. The instructor will review all marks prior to assigning a final grade.

10% - Class Participation - Students will receive a grade for each class they attend, which will reflect how prepared they were, how much they participated in the class, and how effectively the time was used. When calculating the overall grade, the average of the top $N - 4$ classes will be counted, allowing for a reasonable number of illnesses or other conflicts of commitment. This is meant to address all elements of concession and accommodation requests regarding class participation.

20% - Assignments - Students will have regular assignments that will involve writing code and generating plots. Assignments will be designed to be completable during class time, however students may use time outside of class to work on the assignments. Due dates will be provided.

40% - Project - Students will propose and develop their own simulation project. AI use is allowed, but assessment will include identifying student understanding. Students are not allowed to have AI do all the work, but are allowed to use AI as a tool while developing the solution. If AI is used, the final report must include discussion of how AI was used in an iterative fashion. The project grade will be comprised of a portion assigned to a proposal, a mid-term update, the final report, and a project interview.

30% - Final Exam - There will be a final exam during the final exam period that consists of mathematical and conceptual questions covering content from the course pack. This will not involve any coding, but will test student familiarity with the concepts and major issues involved in numerical methods for physics. Questions will be primarily in long answer format (i.e., sentences and paragraphs).

Bonus Marks: Students who find important errors/problems/typos in the course pack will be awarded a bonus mark to a maximum of two per student. Note that only the first person to report the issue will be awarded the bonus marks. Important issues involve ones that create confusion in the language/explanations, or ones that substantially change the conclusions. Bonus marks will not be awarded for small, trivial issues, such as missing punctuation or a minor mispelled word, however notification of such issues are also appreciated.

Academic Integrity

Students are expected to adhere to the academic integrity policy of the University of Victoria. Details on this policy can be found here: `https://www.uvic.ca/calendar/undergrad/index.php#/policy/Sk_0xsM_V`.

Course Materials:

- Required Text: PHYS342 Course Pack
- Recommended Text: *Numerical Methods in Physics with Python*, by Alex Gezerlis. Anticipated cost, $78 new from Amazon.

Resources for Students

UVic Learn Anywhere - https://onlineacademiccommunity.uvic.ca/LearnAnywhere/
Many high schools do not adequately prepare students for how to succeed in university, in large part due to the large differences in expected workload. The UVic Learn Anywhere site can help students use their time more effectively and have better outcomes.

UVic Centre for Academic Communication - https://www.uvic.ca/learningandteaching/cac/
Struggling with homework that involves writing? English not your first language? The Centre for Academic Communication has supports available to help you.

UVic Math and Stats Centre - https://www.uvic.ca/science/math-statistics/current-students/undergraduate/msac/index.php
Struggle with math? No matter the course, the Math and Stats Centre can provide assistance. As long as the assistance is with the mathematics of the problem, there are people available to help.

Academic Accommodations - https://www.uvic.ca/students/academics/academic-concessions-accomm
index.php
Have a disability that might be affecting your studies? The Centre for Accessible Learning can review your diagnosis and provide you with academic accommodations that help reduce the effects of the barriers to education you are experiencing as a result of interactions between course design and your disability.

Student Code of Conduct - https://www.uvic.ca/services/studentlife/student-conduct/index.php
Students are expected to behave with respect towards their environment and their community. When there are allegations of student misconduct, this is governed by the Office of Student Life.

Sexualized Violence - https://www.uvic.ca/sexualizedviolence/
If you have been the victim of sexualized violence, this link will help you know how to take the next steps for resolution.

UVic Policies & Statements

General Information for all Students - https://www.uvic.ca/calendar/archives/202301/undergrad/index.php#/content/62daf5e98b7d47001d0fc38b
This is a list of links to information that may be useful to you.

Academic Concession Policy - https://www.uvic.ca/calendar/undergrad/index.php#/policy/HJjAxiGO4
This policy governs your rights and responsibilities in the case that you experience an unexpected and unavoidable circumstance (e.g. illness, injury, bereavement, etc), or have conflicting responsibilities (e.g. varsity sports event).

Policy on Respectful and Productive Environment - https://www.uvic.ca/calendar/archives/202301/undergrad/index.php#/policy/HkQ0pzdAN
This is a statement and policy about UVic's dedication to a respectful and productive learning environment. This includes human rights, equity and fairness, as well as discrimination and harassment policies.

Policy on Religious Observances - https://www.uvic.ca/calendar/archives/202301/undergrad/index.php#/policy/r1q0gofdN
This policy governs students' rights towards religious observances and how to manage your observances with your course responsibilities.

Policy on Non-Academic Misconduct - https://www.uvic.ca/services/studentlife/student-conduct/non-academic-misconduct/index.php
This policy governs students' rights and responsibilities with regard to non-academic behaviour. Students are expected to treat each other and staff/faculty with respect.

Statement on Equity, Diversity and Inclusion - https://www.uvic.ca/vpacademic/about-contacts/equity-diversity-inclusion/index.php
This is UVic's official statement on equity, diversity, inclusion and anti-racism.