PHYS 3142 Computation Methods in Physics

Course Outline- Spring 2025

Course Title: Computation Methods in Physics

Course Code: PHYS 3142

No. of Credits: 3

Pre-requisite: (COMP 1021 or COMP 1029P) and (MATH 2352 or PHYS 2124)

Exclusion: MATH 3312

Cross campus course equivalence: AMAT 3360

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Course Description

This course provides an introduction to basic numerical and symbolic computation. Topics include methods of interpolation and extrapolation, approximation methods of root finding, numerical integration and solving ordinary differential equations, symbolic algebra and calculus. Students need to write computer codes in laboratory sessions and write lab reports to describe their results.

Intended Learning Outcomes (ILOs)

By the end of this course, students should be able to:

1. Understand the methods of interpolation and extrapolation
2. Understand the approximation methods of root finding
3. Understand symbolic algebra and calculus
4. Understand numerical integration and how to solve ordinary differential equations
5. Learn how to model physical problems so that they can be solved by computational methods
6. Learn how to build programs from numerical or symbolic library routines to solve realistic application problems
7. Learn how to write reports on problem solving activities
8. Gain experience in oral presentation of their work

Assessment and Grading

This course will be assessed using criterion-referencing and grades will not be assigned using a curve. Detailed rubrics for each assignment are provided below, outlining the criteria used for evaluation.

Assessments:

Assessment Task	Contribution to Overall Course grade (%)	Due date
Assignments	60%	Next Thursday after assignment release for each assignment*
Final Project	40%	22/5/2025

* Assessment marks for individual assessed tasks will be released within two weeks of the due date.

Mapping of Course ILOs to Assessment Tasks

Assessed Task	Mapped ILOs	Explanation
Assignments	ILO1, ILO2, ILO3. ILO4	This task assesses students' ability to develop and debug computational code (ILO 1), validate numerical results against theoretical predictions (ILO 2), analyze computational efficiency and limitations (ILO 3), and present findings in a clear report (ILO 4).
Final Project	ILO1, ILO2, ILO3. ILO4	This task assesses students' ability to design and implement a complete computational physics project (ILO 1), evaluate numerical methods and results (ILO 2), critically analyze physical significance (ILO 3), and deliver a clear and structured report with code documentation (ILO 4).

Grading Rubrics

Assignments:

Each assignment includes 100 points for basic questions and extra points for optional questions. Students will get full marks for each question if they correctly complete them by coding and writing a clear report. The maximum mark will be 100 points. If students submit the assignment after the deadline or the report is missing, they can only get at most 80% of the full marks. If students submit the assignment more than two weeks after the deadline, they will get zero marks.

Final Project:

Final Project includes 60 points for base score, 20 points for format score, and 20 points for creativity score. Students will get full base scores if they correctly answer all the questions in the given project (by complete a computational code and writing a clear and structured report). They may get full or partial creativity score if they can explore more to show their creative ideas. They can get full format score only if they can meet all the format requirements provided. If students submit the assignment after the deadline or the report is missing, they can only get at most 80% of the full marks.

Final Grade Descriptors:

Grades	Short Description	Elaboration on subject grading description
A	Excellent Performance	Demonstrates a comprehensive grasp of course content, develops functional and debugged computational code to solve physics problems, and writes clear, professional reports. Shows notable creativity/extension beyond requirements.
B	Good Performance	Shows good understanding of course materials and competence in writing functional computational code to complete assigned tasks. Produces logically structured reports. Demonstrates some independent thinking but may lack depth in critical evaluation or innovation.
C	Satisfactory Performance	Possesses basic knowledge of computational methods and partial success in implementing code to solve standard problems, though with potential minor errors or inefficiencies. Reports meeting minimal formatting requirements and providing limited analysis. Shows effort to achieve core goals.
D	Marginal Pass	Exhibits threshold understanding of key concepts, with code that partially functions but may fail sometimes. Reports are not while organized and lack of analysis. Demonstrates potential to improve with additional guidance and shows some effort to achieve core goals.
F	Fail	Fails to demonstrate comprehension of core concepts. Submitted code is non-functional, incomplete, or even missing. Reports are poorly structured or lack meaningful content. Showing minimal effort. No evidence of critical thinking, problem-solving, or engagement with course objectives.

Course AI Policy

Direct copying of AI-generated content (text/code) is prohibited. However, students can use AI for grammar/language polishing and code optimization.

Communication and Feedback

Assessment marks for individual assessed tasks will be communicated via Canvas within two weeks of submission. Feedback on assignments will include deduction points (grading criteria) and possible suggestions for improvement. Students who have further questions about the feedback including marks should consult the instructor within five working days after the feedback is received.

Resubmission Policy

Resubmissions before the due date are unlimited, but any resubmission after the due date will be considered as late submission unless a valid reason is provided.

Required Texts and Materials

Adopted textbook:
Mark Newman, *Computational Physics* (CreateSpace, Seattle, 2012).

Lecture Notes and Course Homepage:
https://canvas.ust.hk

Other references:
Rubin H. Landau, Manuel J. Paez, and Cristian C. Bordeianu, *Computational Physics* (Wiley-VCH, Weinheim, 2007).
Alejandro L. Garcia, *Numerical Methods for Physics*, (Prentice Hall, Upper Saddle River, NJ, 2000), 2nd Edition.
Paul L. DeVries and Javier E. Hasbun, *A First Course in Computational Physics* (Jones & Bartlett, Burlington, MA, 2010).
William H. Press, Saul A. Teukolsky, William T. Vetterling, and Brian P. Flannery, *Numerical Recipes: The Art of Scientific Computing*, (Cambridge University Press, Cambridge, 2007), 3rd Edition.

Academic Integrity

Students are expected to adhere to the university's academic integrity policy. Students are expected to uphold HKUST's Academic Honor Code and to maintain the highest standards of academic integrity. The University has zero tolerance of academic misconduct. Please refer to Academic Integrity | HKUST – Academic Registry for the University's definition of plagiarism and ways to avoid cheating and plagiarism.

[Optional] Additional Resources

None