

National Cheng Kung University

Modular Courses 2026 Summer Program

Academic Year : 115, Semester : 1

Category : Natural and Engineering Sciences

Python應用計算物理 - 連續動力學

Computational Physics via Python – Dynamics of Continuum

Instructor	Affiliation	Graduation (Ph.D.)
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Course Type	Course Credit	Student Size (Maximum)
Lecture + Recitation	1.5	15

Student Background

College of Science, College of Engineering,

College of Electrical Engineering and Computer Science

Sophomore level (2nd year college level) math and general physics.

Difficulty

☐ Challenging ☒ Moderately Difficult ☐ Medium ☐ Entry Level (Basic)

Format of The Course

Lecture 60%, Hands-on Practice 30%, Discussion 10%

Remark:

Individual students ↔ instructor direct discussions to concretize the contents of the lecture into numerical codes (> 30 minutes).

Grading Policy

- Exams and Quizzes 30%:
Short Quiz on the very basic of numerical algorithm and PDE solutions (~ 60 min on Friday).
周5安排一次基礎的偏微分方程的數值演算法和解法Quiz，時間60分鐘。
- Reports 70%:
One final report on using computers, due on Monday after the class week.
報告課程結束後周一繳交。

Code of Conduct for The Course

Sophomore level (2nd year college level) math and general physics.

Course Description

Theoretical and computational modeling of continua (described by Eulerian variables: fluids and field quantities) is a central scientific tool in physical sciences and engineering (aerodynamics, nonlinear optics, charge particle dynamics and space technology to name a few examples). Despite the fact that the world in reality is made out of a system of discrete points, the idea of “continua” has been successful in describing various phenomena due to the interaction at the molecular level. In this course, through an assistance of numerical computations, we study diffusion (equivalently heat conduction), convection, and wave (linear and nonlinear) dynamics. With an expanding feasibility of the programming language Python, the course will cover succinct and paradigmatic examples.

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連續體的理論和其相關的計算建模（由歐拉變數描述：流體和場量）是物理科學和工程（空氣動力學、非線性光學、帶電粒子動力學和太空技術等）的核心科學工具。儘管現實世界是由離散點的系統組成的，但「連續體」的概念已經成功地描述了許多由分子層面上的相互作用而產生的自然現象。在本課程中，透過數值計算的幫助，我們研究擴散現象（等價於熱傳導）、對流和波（線性和非線性）動力學。隨著 Python 程式語言的可適用性不斷增強，本課程將有簡潔、典型的例子。

Keywords: Numerical simulation, Partial Differential Equations (PDE), Linear and nonlinear waves, Schroedinger equation, Soliton, Python

關鍵字：數值模擬、偏微分方程、線性與非線性波、薛丁格方程式、孤子波, Python

Timetable and Syllabus

Period	Timetable	Syllabus
2026/8/31(Mon)	09:00 – 15:30	9:00-12:00 : Lectures: Introduction to modeling dynamics of continua by partial differential equations. 12:00-13:00 : Lunch time 13:00-15:30 : Introduction to programming (1) Add one to ten (2) Numerical integration. Laptop PCs with compilers will be provided to all the students. Individual students↔ instructor direct“Discussions” to concretize the contents of the lecture into numerical codes (>30 minutes).
2026/9/1(Tue)	09:00 – 15:30	9:00-12:00 : Lectures : Quick review of Fluid and Electrodynamics (Continuum or Eulerian variables). Poisson/Helmholtz equations and analytical solutions. 12:00-13:00 : Lunch time 13:00-15:30 : Practice : Iterative (Gauss-Seidel) and Direct (Gaussian-elimination) solvers. Discussions > 30 minutes.
2026/9/2(Wed)	09:00 – 15:30	9:00-12:00 : Lectures : Diffusion equation and analytical solutions. 12:00-13:00 : Lunch time 13:00-15:30 : Practice : Implicit (Cranck-Nicholson, Thomas algorithm) versus explicit solver. Courant–Friedrichs–Lewy (CFL) conditions. Discussions > 30 minutes.
2026/9/3(Thu)	09:00 – 15:30	9:00-12:00 : Lectures : Linear wave, Burgers’, and KdV equations. 12:00-13:00 : Lunch time 13:00-15:30 : Practice : Explicit solver by Leap-frog and Upwind schemes. Discussions > 30 minutes.
2026/9/4(Fri)	09:00 – 15:30	9:00-10:00 : Quiz 10:00-12:00 Lectures : Schroedinger equation in quantum mechanics, nonlinear Schroedinger equation (NLS) in optical fibers, and Zakharov equation describing nonlinear phase of Lanngmuir waves. Inverse scattering methods in KdV and NLS. 12:00-13:00 : Lunch time

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		13:00-15:30 : Practice : Numerical solutions of nonlinear Schroedinger equation by Leap-Frog and Split-Step-Fourier methods. Discussions > 30 minutes.
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Goal of the Course

1. Learn how numerical simulation can discover new physical phenomena.
2. Learn scientific programming by solving simple PDEs (Poisson, Diffusion, and Wave).
3. Learn dynamics of nonlinear waves, by examining solutions of Burgers', KdV (Korteweg-De Vries), and non-linear Schroedinger equations.

The Importance, Cross-Over Disciplinary and Contemporary of The Curriculum

Theoretical and computational modeling of continua (described by Eulerian variables: fluids and field quantities) is a central scientific tool in physical sciences and engineering. Mechanical engineering, aerodynamics, aeronautics, nonlinear optics, charge particle dynamics, space technology to name a few. 連續體的理論和計算建模（由歐拉變數描述：流體和場量）是物理科學和工程中的核心科學工具。機械工程、空氣動力學、航空學、非線性光學、帶電粒子動力學、太空技術等等。

Remarks

Course Materials: Hand-written and typed notes will be uploaded to moodle.

本課程若因天災等不可抗力之因素或中央、地方政府公告停課，授課教師需依情況依建議補課方式調整課程進度與補課；若需使用假日、國定假日補課，則需與所有修課學生達成共識方能用例假日補課。

建議補課方式：

1. 線上授課方式補課；
2. 當預期可能會因天災(颱風、超大豪雨...等)宣佈停課時，建議老師先行調整加快課程進度或預先增加可能天氣預警之前幾次課程時數；
3. 停課後隔天起延後下課，補足停課延誤的進度；若停課超過1天，則在開始上課後延後下課補課，或當週星期六、日補課；

更改課程授課方式，例如：DEMO 改以考試、報告、作業取代。