National Cheng Kung University
Modular Course 2023 Summer Program

計算物理習題演練
Exercise in Computational Physics

Instructor	Affiliation	Graduation (Ph.d.)
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Course Type	Course Credit	Class Capacity (Maximum)
Lecture + Recitation	**1**	**12**

Student Background

College of Science、College of Engineering、College of Bioscience and Biotechnology、College of Electrical Engineering and Computer Science、College of Medicine、College of Management、College of Planning and Design、College of Social Sciences

Needs knowledge of basic calculus

Difficulty

☐ **Challenging** ☐ **Medium Well** ■ **Medium** ☐ **Entry Level (Basic)**

Format of The Course

Lecture 75%, In class exercise with hands on training 25%

Grading Policy

In class exam 20 %：A 60 minutes quiz，Report 80%

Note:

Three “programming + physics interpretation” based reports. Two of them (20% + 30%) due Wednesday and Friday during the week of the course, and one of them (30%) due next Tuesday after the course.

Code of Conduct for The Course

A freshmen level, basic knowledge of calculus.

Course Description

Numerical modeling and solving (differential) equations numerically are becoming crucial skills for students and researchers in the STEM field. However, many students tend to have an image of difficulties in getting into “programming” or “numerical computation” (it’s not difficult at all!). This course will lower the threshold at the entrance level of computing by providing students with simple but paradigmatic examples. The course will start by adding “1 to 10 (which is 55)” by setting up the loop. Once one gets through this simple stage, the rest becomes quite straightforward. The course will focus on numerical integration and solving ordinary differential equations. Monte-Carlo and molecular dynamics approaches are also referred to. The course will take an interactive style to give the students hands on training. Open for all the levels, even for those who do not have any experiences in programming language at all (or those who has missed chances to learn high level programming language up to senior or graduate level)

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Timetable and Syllabus

Peroid	Timetable	Syllabus
	14:00-17:40	**Introduction to programming. "Add one to ten" by using the loop. Numerical derivative and numerical integration.**
	14:00-17:40	**ODE solve by Euler (1st order) and improved by Euler (2nd order) methods.**
	14:00-17:40	**Computation of planetary motion (Kepler's problem). Central (~1/r^2) force.**
	14:00-17:40	**Computation of charged particle motion. A sixty minutes quiz on numerical algorithm.**
	14:00-17:40	**Monte-Carlo simulation. Simple exercise in parallel computing employing MPI**

Goal of the Course

1. **Understand and become familiar with high-level computational language (C and F95, for example).**
2. **Understand how to model dynamical system and how to solve ordinary differential equations by numerical methods.**
3. **Become familiar with parallel computing employing simple examples in Message Passing Interface (MPI) on a Linux platform.**

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

[Importance of the course contents]

Numerical modeling and solving (differential) equations by numerical methods are becoming increasingly crucial skills for students and researchers in physical sciences and engineering. Life sciences and social sciences are not exceptions. Most of the problems we deal with in a real life are not solvable by a pure analytical approach. Numerical modeling is also an intellectual practice. During students' learning process, numerical computation also acts as a touchstone to examine the accuracy of their knowledge (unless the mathematical formulation and implementation is 100% correct, numerical solutions will provide us with erroneous results).

[Interdisciplinary nature of the course]

Numerical computing is applicable to all the fields of natural sciences, engineering, and social sciences. The specific physics problems to be discussed in the class are omnipresent ones for all the majors.

Remarks

References：

W.Cheney and D.Kincaid, Numerical Mathematics and Computing, 7th edition (2012). Brooks/Cole. Chapters 5 (5.1) and 7 (7.1 and 7.2).

Teaching Material：Slides and sample programs by the instructor.

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