Mathematics and Coding on Physics II: administrative information (112−2)

Course [PHYS222] Mathematics and Coding on Physics II, Mon. 13:10–15:00 & Thu. 16:10–17:00.

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Office hours Mondays and Tuesdays, 15:10–17:10. 理SC 2006–1.

Webpage https://www2.nsysu.edu.tw/iwamoto/physmath2.html

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Evaluation Midterm and term exams (mandatory), coding and other assignments (optional[*1]), and classroom performance (optional). With midterm-exam score A (out of 60), term-exam score B (out of 40), and extra points C (max 50) determined based on assignments and performance, the grade is given by $\max[A+B, f(A+B)+C]$, where $f(x) = 0.25\sqrt{500x - x^2}$ (half-up rounding).

Themes and topics

An intermediate-level mathematics course designed for physics learners. We will cover linear algebra, Fourier analysis, special functions, and methods of numerical analysis. Prerequisites for this course include a foundational understanding of calculus, vector and matrix arithmetic, and ordinary differential equations.

After reviewing the basics of matrices, you first learn **linear algebra** with an emphasis on practical handling of matrices and **eigenvalue problems**. Motivated students are expected to reach the concept of **vector space**. You then learn basic topics of function analysis, particularly **Fourier analysis** and **special functions**.

Additionally, the course introduces fundamental concepts in numerical analysis and basic numerical methods for mathematical problems such as ordinary differential equations. Students will gain theoretical knowledge in numerical analysis as well as practical coding skills in Python, using the contemporary Python ecosystem.

This course does not cover the mathematical foundations of each topic. Instead, students are expected to be familiar with the topics and develop an appreciation of their usefulness.

Textbook

E. Kreyszig, Advanced Engineering Mathematics, 10th ed. Taiwan custom version, Wiley (2018).

- **You need the textbook**[*2] , preferably a physical book rather than an e-book.
- You are assumed to have learned Chapters 1, 2, 9, and 10. We discuss 7, 8, 11, 5, and 21.

Special remarks on Computer environment

We are going to use `Python 3.x` ($\geq$ `3.8`) and GitHub Classroom. Students need **a GitHub account** and a computer that can run `Python 3`. In addition, you are recommended to install and use Visual Studio Code as the primary editor. Further instructions are given during the lectures.

[*1] Due to possible technical problems in newly-built systems, coding assignments are officially set as optional. However, given the situation of the modern civilization as well as the curriculum structure, we should consider them as mandatory tasks and considerable weight is given in the grading.

[*2] You will have disadvantages if you do not have (printed version of) the textbook. No compensation will be provided for those disadvantages.

Student's goals

At the end of this course,

- I am familiar with matrices and vectors. In particular, I can explain “vector space”, “basis”, “linear transformation”, “matrix rank”, and “eigenvectors”.
- I can perform Fourier analysis of functions and explain its physical interpretation.
- I know several special functions and their basic properties.
- Utilizing computers and online resources, I can numerically solve problems in linear algebra.
- I can use Python to find numerical solutions to basic differential equations.

Schedule

2.19·22	⟨1⟩	Matrix and vector.	§7.1–7.2
2.26	⟨2⟩	Rank. Vector space. Determinant.	§7.4–7.8
2.29		Setup of coding environment. Python ecosystem.	
3.04	⟨3⟩	Floating-point number (IEEE 754). Introduction to numerical analysis.	
3.07		Linear-equation system. Determinant.	§7.3, 7.8
3.11·14	⟨4⟩	Vector space.	§7.9
3.18·21	⟨5⟩	Eigenvalue problem.	§8.1–8.2
3.25·28	⟨6⟩	Matrix diagonalization.	§8.3–8.5
4.01	⟨7⟩	Recap of vector calculus.	§9–10
4.08·11	**Midterm Exam** (exam review on Apr. 11)		
4.15·18	⟨8⟩	Fourier series.	§11.1–11.4
4.22·25	⟨9⟩	Strum–Liouville problems.	§11.5–11.6
4.29·02	⟨10⟩	Fourier transformation.	§11.7–11.10
5.06·09	⟨11⟩	Special functions.	§5.1–5.2
5.13·16	⟨12⟩	Special functions. Frobenius Method.	§5.3–5.4
5.20·23	⟨13⟩	Numerics for ODEs.	§21
5.27·30	⟨14⟩	Numerics for ODEs.	§21
6.03·06	**Term Exam** (exam review on June 6)		
6.13	⟨15⟩	No Lecture (flexible week)	
6.17·20	⟨16⟩	Basic group theory. Topics requested by students.	

- The flexible week ⟨15⟩ has no lecture, compensating for the coding assignments.[*3][*4]
- The flexible week ⟨16⟩ is not included in the evaluation.

[*3] Sho is away for a conference. We may have a one-hour make-up class on the last week upon your request.

[*4] It seems that we need to have a one-hour lecture in the flexible weeks because two hours are cancelled by the holiday (June 10) and three hours are consumed for the assignments. We will discuss the schedule of the weeks later.

(1) Introduction of Lecturer and TA

(2) On This Course

2.1 Administrative Information → see Page 1 of syllabus.

- Google Classroom for official announcements.
- GitHub Classroom for your submissions of coding assignments.
  - My first lecture with coding; we will have inconveniences. I apologize in advance.

2.2 Intentions

- Math: Usually you don't need. Sometimes you can't do anything if your knowledge is short.
  - Boring, but you need to learn once. (secret: You can forget almost all after the exam.)
- Coding: People do, but they know nothing. You need to do even if you can't understand any.

2.3 Prerequisites

- The previous lecture by Chia-Yi (Math and Coding on Physics I).
- **You have the textbook**, preferably as a physical book.

2.4 Textbook

- Required. **Printed is better than e-book**, as Sho may forbid to use tablets in some activities.

2.5 Evaluation and Make-up Principles

- Two exams: mandatory, midterm 60 points, term 40 points. No make-up.
  - If you have reasons for absence, you must follow *Regulations for Leave Application*[*5]. Otherwise, your grade will be **X**.
- Coding and math assignments, classroom performance: max 50 points. Not mandatory.
  (Some points may be given by Sho's unfair decretion.)
  - Make-up will be provided for official leaves 公假 or COVID-19 if officially applied[*6].
  - No make-up for other health issues. Other reasons are assessed on a case-by-case basis.
- Students with disabilities are encouraged to contact *the student affairs office*[*7] for assistance. Special academic accommodations/considerations are provided based on their advice.

[Hint: Notice the two-fold grading, so that you can pursue whichever you like.
(1) Meritocracy: good in exam ⇒ good grade. Fair, boring, antiquated.
(2) With performance: Respecting your active voluntary attitude. Unfair, pedagogic, inclusive.]

2.6 Lecture = activity + lecture + numerics (coding-related topics).

- Sho expects you did minimal homework and submitted Weekstarter quiz.
- **No points are given for activity** if you have not submitted the weekstarter.

[*5] 學生考試請假及補考辦法 https://oaa.nsysu.edu.tw/var/file/3/1003/img/1296/acade_rule_09.pdf
[*6] Apply on https://sis.nsysu.edu.tw/ . Indigenous peoples' festival holidays are respected.
[*7] 學務處諮商與健康促進組（特教生服務） https://ccd-osa.nsysu.edu.tw/p/412-1091-24059.php

Lecture rules

Principles: (1) We are colleagues, so we create lecture together.

(2) You are adult, so you can do anything except for disturbing me.
Conflicts between students are to be solved by students.

- **You must interrupt Sho** if you have questions/comments.[*8]
- You can drink water/non-alcoholic beverage or eat small candies/gums/chocolates (as long as room-regulation allows).
- In principle, you can use computers, tablets, smartphones, etc.
  - It will disturb your concentration. It is your own risk.
  - It may be forbidden in some activities.
- Do not eat "foods." Do not drink alcohol.
- Do not talk over phones.
- **[VOTE]** Should we kick-out students who are talking with others during lectures?

2.7 Other Remarks

Scientific remarks

- The difference between Sho's and Textbook's notation: (You can use either.)
  - Matrices and vectors: $A, B, C, ..., \vec{a}, \vec{b}, \vec{c}, ...$ vs $\mathbf{A}, \mathbf{B}, \mathbf{C}, ..., \mathbf{a}, \mathbf{b}, \mathbf{c}, ...$
  - Cartesian unit vectors: $\vec{e}_x, \vec{e}_y, \vec{e}_z$ vs $\mathbf{i}, \mathbf{j}, \mathbf{k}$.

Administrative remarks

- You are very welcome to visit Sho during the **office hours**, but also in any other time.
- High-quality homework submissions from you might be shared with (but only with) people in this lecture, where your name will be hidden.
- Sho is extraordinarily strict against **plagiarism**.
  - Please read NSYSU's *Guidelines for Students' Academic Ethics and Handling of Cases in Violation of the Academic Ethics*. The guidelines, in particular Article II (3), (4), and (6), are taken into account when Sho evaluates students' reports or exam/quiz answers.[*9]

University Principles (Sho's subjective opinion; for reference)

1. **No longer kids**. We are colleagues.
2. Learn by yourselves. **You'll never be taught.**
   - I don't teach. I'm not your teacher 老師 but a lecturer 講師.
   - ★ 1 credit (學分) = (50 minute lecture + 100 minute self-study) of 18 weeks.
3. Do own duty.
   - I do lectures to receive salary. You get ≥ 60 points in exams/activities to receive credits.
   - ★ "Teach you physics" is not my duty. "Attend lectures" is not your duty.
4. Ask for help. Friends, colleagues, professors, secretaries, TA, ...
   - **Nobody helps you** if you don't ask for help. Everyone will help you if you ask.
   - ★ Take care of **mental health**, money, academic honesty, credit, and colleagues/family.

[*8] You should think this is **your duty** in all university lectures. Our job is not to finish the materials but to help you learn. Furthermore, you can help other students by asking questions! When you have questions, usually others have the same one (and it is Sho's fault). It also helps Sho, because Sho can improve the lecture.

[*9] An example: Imagine you are writing a report. If you "use" some books or others' reports, you must write so. If you had a discussion with others, you must write so.