

# Math 2102 - Linear Algebra II

HONG KONG UNIVERSITY

Spring 2024

Updated: February 1, 2024.

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| <b>Instructor:</b>    | Aron Heleodoro                                   |
| <b>Office:</b>        | Run Run Shaw Building 211                        |
| <b>E-mail:</b>        | <a href="mailto:aronah@hku.hk">aronah@hku.hk</a> |
| <b>Lecture time:</b>  | M 11:30-12:20 Th 10:30 - 12:20 (HKT)             |
| <b>Lecture place:</b> | K. K. Leung Building 102                         |
| <b>Tutors:</b>        | <a href="#">Andy Kong</a>                        |
| <b>Tutors:</b>        | <a href="#">Yuqiao Zhao</a>                      |
| <b>Student TA:</b>    | Yuheng Wan                                       |
| <b>Website :</b>      | <a href="#">Math 2102</a>                        |

Please refer to the [course website](#) for updated information on the syllabus, course schedule and homework assignments.

## Learning Goals:

- demonstrate an understanding of key concepts and ideas in abstract linear algebra and be able to identify the appropriate theorems and their applications;
- present correct logical reasoning via formal proofs (written and verbally);
- carry out computations using the theory learned;
- familiarize oneself with the different uses and power of linear algebra in other abstract areas of math.

**Objectives:** The main goal of this class is for students to learn the general theory of abstract linear algebra, its main theorems and applications from an abstract point of view. Here is a list of concepts that we expect you to understand at the end of this course:

- 1) basic notions about abstract vector spaces as basis and fundamental properties of them;
- 2) the notions of kernel and image of a linear operator and their properties;
- 3) existence of eigenvalues over the complex numbers;
- 4) relation between linear maps and matrices and existence of upper-triangular form;
- 5) results of linear algebra on inner product spaces, e.g. Cauchy–Schwarz inequality, Gram–Schmidt procedure and Riesz representability
- 6) spectral theorem over real and complex numbers;
- 7) singular value decomposition and some consequences;
- 8) the notion of generalized eigenspaces and the generalized eigenspace decomposition over the complex numbers;

- 9) Jordan normal form over the complex numbers;
- 10) notion of tensor product, alternating product, and their basic properties;
- 11) coordinate-free definition of determinant and its properties.

We will closely follow the exposition in the textbook, supplemented with my own Lecture notes and additional readings for topics not covered in the textbook.

**Lectures:** We will meet twice a week for lectures: Mondays and Thursdays.

**Tutorials:** you should try to attend one of the following tutorial sessions. *They will start on the week of Jan. 29.*

| Time                     | Place   | Tutor  |
|--------------------------|---------|--------|
| Monday: 14:30 - 15:20    | KKLG110 | Andy   |
| Tuesday: 16:30 - 17:20   | KKLG110 | Andy   |
| Wednesday: 12:30 - 13:20 | LE6     | Yuqiao |

The tutorials will be an active-learning session. You will be given half of the time to work on exercises: these will normally be from the lecture notes or worksheets. The other half of the class you will discuss the solutions together. It is important to be proactive and volunteer to present solutions or comments on your peers are trying to do.

**Consultations:** these will start on the week of Jan. 22.

| Time                    | Place    | Person |
|-------------------------|----------|--------|
| Thursday: 16:30 - 17:20 | T4       | Aron   |
| Friday: 10:00 - 12:00   | RR 214   | Yuqiao |
| Friday: 15:30 - 17:20   | CPD 3.21 | Aron   |

**Reading assignments:** These will be posted on Perusall twice a week. The purpose of using this platform is to provide you with an opportunity to familiarize yourself with the material of the class prior to class. These readings will be graded, see the Perusall section below. See also the notes to Meetings 2-3 for more on the grading.

**Student TA:** We will have one undergraduate TA, Yuheng Wan, will be available twice a week for more small group discussions and tutoring. Mondays (17:30 to 19:20 in MB122) and Fridays (17:30 to 19:20 in KK-LG101). The goal of these is to help you parse the material of Thursday classes and to provide help with the homework assignments, which will be due Monday evenings.

**Textbook:** *Linear Algebra Done Right*, by Sheldon Axler. The book was published as open access, you can download a copy [here](#).

**Platforms:**

- [Moodle](#) will be used to see your grades.
- **Perusall** will be used to read the textbook together and have discussions about it. **Important:** you should access Perusall via Moodle you will have an account linked to Moodle. **Do not create a separate account on Perusall.**

### Participation:

Participation in class is very important. I will not take attendance but I expect the students to be engaged while in class, which means asking questions and interacting with the instructor and your peers. The same is expected for the tutorial sessions.

### Assessments:

- **Perusall. (10 %)** *Reading assignments and online discussion.* The Perusall platform will be used to assign readings from the textbook and extra material. It is also a place where you can engage in discussion with other students by posting and replying to comments within the document. This grade will be determined by the quantity and quality of your comments and engagement with the reading material and other people's questions and comments. I will assign two readings a week, one due Sunday night and the other due Wednesday night. Active participation is important. I will regularly check the discussions on Perusall to gear the lectures towards the points where students are more confused. **Important:** you should access Perusall via Moodle you will have an account linked to Moodle. **Do not create a separate account on Perusall.**
- **Homework. (20 %)** *Roughly every **two** weeks.* These should be neatly written and turned in on time. I will set up a place to turn it in on Moodle. For every 24-hour period that the homework is late you will lose 10 % of the grade. After I publish the solutions (roughly one week after) the homework won't be accepted. The first 24-hours after the deadline are a grace period, but turning it after 24-hours will take 20 % off your homework. Homework assignments will be due on Monday (see the course schedule for details).
- **Midterms. (20 %)** *We will have two midterms.* Mark your calendar:
  - **Mar. 7:** in class KK101, Midterm 1 will cover the material from *Meetings 1-15*.
  - **Apr. 11:** in class KK101, Midterm 2 will cover the material from *Meetings 16,19-28*.
- **Final. (50 %)** *The final exam will cover the material of the whole course.* It will be a closed book exam.  
Mark your calendar: **TBD**.

*No make-up exams. Rubrics for the specific assignments will be presented later.*

### Class Policy:

- You are expected to turn in all the assignments. Late submission will affect the grade, unless it is justified.
- If you require accommodations, please don't hesitate and reach out as soon as possible, so we can make sure the course works for everyone from day one! For more information see the University Policy below.

- Communication is key. If you are struggling, please communicate with me or one of our TAs. We want you to succeed, but we can do that only if you let us know. We are a team, so please don't be afraid to reach out!

**University Policy:**

- This class is subject to all the rules specified in the university policy at:  
[https://www.hku.hk/about/policies\\_reports.html](https://www.hku.hk/about/policies_reports.html).
- Students that need special accommodations are referred to Special Education Needs (SEN) Support at:  
<https://www.cedars.hku.hk/cope/sen-support/sen-resources>.