MATH 2431 Honors Probability (Spring 2025)

– Version of 24/01/2025 –

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3. Meeting Time and Venue
Lecture: *Date / Time:* Tuesdays and Thursdays 9:00 AM – 10:20 AM.
Venue: Room 1410 (Academic Building), near Lifts 25–26.
Tutorials: *Date / Time:* Thursdays 7:00 PM – 7:50 PM.
Venue: Room 2304 (Academic Building), near Lifts 17–18.

4. Course description
Credit Points: 4
Pre-requisite: Grade A- or above in MATH 1014 or MATH 1020 or MATH 1024
Co-requisite: MATH 2011 or MATH 2023
Exclusions: ELEC 2600, ELEC 2600H, ISOM 3540, MATH 2421

Brief information / synopsis:

This is an honors undergraduate course in probability theory. Topics include probability spaces and random variables, distributions (absolutely continuous and singular distributions) and probability densities, moment inequalities, moment generating functions, conditional expectations, independence, conditional distributions, convergence concepts (weak, strong and in distribution), law of large numbers (weak and strong) and central limit theorem.

Some rigorous theoretical results in probability will be discussed.

5. Intended Learning Outcomes
On successful completion of this course, students should be able to:

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1	Recognize and use appropriately the modern mathematical language of probability theory.
2	Remember the most important distributions, their motivations, properties, and applications.
3	Understand the fundamental limit theorems and the related techniques of the proofs.

6. Assessment Scheme

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.

The letter grade will be based on the total weighted average of the percentages of points in homework problems as well as the midterm and final exam; this weighted average is determined either via *Grading Scheme I*

Homework problems	20%
Midterm exam	20%
Final exam	60%

or *Grading Scheme II*

Homework problems	20%
Midterm exam	0%
Final exam	80%

in such a way that the *higher* score is taken.

The (tentative) **grade cutoffs** will be announced after the midterm exam.

Homework problems: Assigned *weekly* on Tuesdays, on the Canvas website, and to be handed in online or in class *the following Tuesday* − 12 problems sets in total over the course of the semester. The score of the two lowest submissions will not be counted.

Exam dates and coordinates: **TBA**.

Make-up policy for exams / late submission of homework problems:

- Students who have valid reasons for missing the midterm exam (such as time conflict with another midterm exam) will be offered to take a re-take midterm exam (but with different problems), or otherwise be automatically graded according to *Grading Scheme II*.
- For the final exam, the course will follow the make-up exam policy set by Academic Registry (ARO). Approval from the instructor, the dean, and ARO will be needed for applying for a make-up final exam, and students need to complete the make-up final exam within one week after the approval decision from ARO. In any circumstance, the make-up final exam will use a different set of problems, and there is no guarantee that the level of difficulty remains the same as the regular sitting.
- No late submission of homework problems will be accepted unless there are valid reasons (such as illness, time conflict due to a midterm exam of another course). In case of a planned time conflict, extensions will not be granted retroactively, but must be granted *before* the submission deadline.

Grade descriptors

Grade	**Short description**	**Elaboration on subject grading description**
A	Excellent Performance	Demonstrates a comprehensive grasp of probability theory, including all fundamental theorems covered in the present course, expertise in solving problems in the field, and independent thinking. Exhibits a very strong working knowledge capable to study advanced topics in probability independently.
B	Good Performance	Shows good knowledge and understanding of the main concepts and theorems in probability theory, and competence in problem-solving, but is not yet at a level required to independently study more advanced topics in probability.
C	Satisfactory Performance	Possesses adequate knowledge of core concepts and fundamental results in probability theory, as well as basic techniques introduced in this course.
D	Marginal Pass	Possesses very basic knowledge of some of the main themes presented in this course.
F	Fail	Does not exhibit any knowledge of probability theory and is unable to solve any related problems.

7. Course AI Policy

You are allowed to use generative AI for homework assessments **only if properly acknowledged**. Please note however that relying in an unreflected way on AI-generated content is heavily discouraged, and will not be permissible in final exams.

8. Learning Resources

This course will *not* follow a single textbook. Instead, typed **lecture notes** will be provided on the Canvas website as the course progresses.

- **Main references**:

  [Geo12] H.-O. Georgii: *Stochastics: Introduction to Probability and Statistics*, Second Edition, De Gruyter (2012).

  [GS01] G. Grimmett and D. Stirzaker:*Probability and Random Processes*, Third Edition, Oxford (2001).

- **Other useful references**:

  [DS10] M. H. DeGroot and M. J. Schervish: *Probability and Statistics*, Addison-Wesley (2010).

  [Dur09] R. Durrett: *Elementary Probability for Applications*, Cambridge University Press (2009).

  [Bre88] P. Bremaud: *An Introduction to Probabilistic Modeling*, Springer (1988).

Some further references may be given in the Lecture Notes.

9. Course Schedule

The course will roughly follow the schedule below:

- **Chapter 1:** Outcomes, events and probability ($\sim$ 1 week).
- **Chapter 2:** Conditional probability and stochastic independence ($\sim$ 1 week).
- **Chapter 3:** Discrete distributions ($\sim$ 0.5 weeks).
- **Chapter 4:** Continuous distributions ($\sim$ 1 week).
- **Chapter 5:** Random variables, laws and cumulative distribution function, transformations ($\sim$ 1.5 weeks).
- **Chapter 6:** Expectation and moments of random variables ($\sim$ 0.5 weeks).
- **Chapter 7:** Joint distribution of random variables, covariance and correlation, extremes ($\sim$ 2 weeks)
- **Chapter 8:** Hölder and Jensen inequalities ($\sim$ 0.5 weeks)
- **Chapter 9:** Conditional distributions and conditional expectation ($\sim$ 1 week)
- **Chapter 10:** Generating functions and applications ($\sim$ 1 week)
- **Chapter 11:** Convergence in probability, almost sure convergence and the law of large numbers ($\sim$ 1 week)
- **Chapter 12:** Weak convergence and the central limit theorem ($\sim$ 1 week)
- **Chapter 13:** Overview of random processes ($\sim$ 0.5 weeks)

10. Academic Integrity

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