MATH 2421 Probability (Fall 2025)

– Version of 09/09/2025 –

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Office hours: Tuesdays, 12:30 PM – 2:00 PM in Office 3490.

2. Teaching Assistants:

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3. Meeting Time and Venue
Lecture: *Date / Time:* Tuesdays and Thursdays 9:00 AM – 10:20 AM.
Venue: Room 4619 (near Lifts 31/32).
Tutorials: For *Date / Time & Venue* see Canvas website.

4. Course description
Credit Points: 4
Pre-requisite: MATH 1014 or MATH 1020 or MATH 1024.
Co-requisite: MATH 2011 or MATH 2023.
Exclusions: IEDA 2520, MATH 2431, ELEC 2600, ELEC 2600H (prior to 2022-23), ISOM 3540.

Brief information / synopsis:

This is an undergraduate introductory course in probability theory. Topics include sample spaces, conditional probability, random variables, independence of events, discrete and continuous distributions and random variables, expectation, correlation, moment generating functions, distributions of function of random variables, and limit theorems (law of large numbers; central limit theorem).

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

No.	ILO
1	Recognize technical terms and definitions in probability theory and use them appropriately in applications.
2	Use Kolmogorov's axioms and their consequences to calculate specific probabilities in applied contexts.
3	Understand the concepts of discrete and continuous random variables and associate them with various random experiments.
4	Solve specific problems using the laws of large numbers and the central limit theorem.

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*

Assessment task	Contribution to course grade	Due date
Homework problems	15%	See Canvas website
Midterm exam	35%	**16/10/2025**
Final exam	50%	**TBA**

or *Grading Scheme II*

Assessment task	**Contribution to course grade**	**Due date**
Homework problems	15%	See Canvas website
Midterm exam	0%	**16/10/2025**
Final exam	85%	**TBA**

in such a way that the *higher* score is taken. Assessment marks for individual assessed tasks will be released within two weeks of the due date.

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

Homework problems: Assigned *bi-weekly* on Tuesdays, on the Canvas website, and to be handed in online *on Tuesday two weeks after release.* Some homework problems will be replaced by *quizzes*, which follow the same rules.

Exam dates and coordinates:

- Midterm Exam: Thursday, 16/10/2025, during class hours (9:00 AM – 10:20 AM), room **TBA**.
- Final Exam: **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.

Mapping of ILOs to Assessment Tasks

Assessment Task	**Mapped ILOs**	**Explanation**
Homework Problems	ILO 1, ILO 2, ILO 3, ILO 4	The homework problems assess the students' problem solving skill, pertaining to all ILOs.
Midterm Exam	ILO 1, ILO 2, ILO 3, ILO 4	The midterm exam assesses the students' problem solving skill, pertaining to all ILOs.
Final Exam	ILO 1, ILO 2, ILO 3, ILO 4	The final exam assesses the students' problem solving skill, pertaining to all ILOs.

Grading Rubrics

Each assignment will have a maximum credit. Full marks will be assigned for correct answers will fully explained reasoning (whenever appropriate).

Final Grade descriptions

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 using AI will not be permitted in the midterm or final exam.

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 reference**:

  [Ros19] S. Ross: *A First Course in Probability*, Tenth Edition, Pearson (2019).

- **Other useful references**:

  [Bré88] P. Brémaud: *An Introduction to Probabilistic Modeling*, Springer (1988).

  [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).

  [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).

References marked with ‡ are slightly more advanced and include notions that go beyond the scope of MATH 2421. Some further references may be given in the Lecture Notes.

9. Course Schedule

The course will roughly follow the schedule below:

- **Chapter 1 - Combinatorics**: principle of counting, permutations, combinations, multinomial coefficients, number of integer solutions of equations ($\sim$ 2 weeks).
- **Chapter 2 - Kolmogorov's axioms of probability**: operations on events, first properties ($\sim$ 1 week).
- **Chapter 3 - Conditional probability**: law of total probability, Bayes' theorem, stochastic independence ($\sim$ 1 week).
- **Chapter 4 - Random variables**: definition, expected values, variance and standard deviation, classical discrete distributions (uniform, binomial, geometric, Poisson), cumulative distribution functions ($\sim$ 2 weeks).
- **Chapter 5 - Continuous random variables**: probability density functions, expectation and variance, classical continuous distributions (uniform, normal, exponential, Γ, β, Cauchy) ($\sim$ 2 weeks)
- **Chapter 6 - Jointly distributed random variables**: Joint cumulative distribution function, covariance and correlation, sums of independent random variables ($\sim$ 2 weeks).
- **Chapter 7 - Conditional distribution and conditional expectation:** Definition, calculation in the discrete and jointly continuous cases ($\sim$ 1 week)
- **Chapter 8 - Generating functions:** Moment and probability generating function, applications ($\sim$ 0.5 weeks)
- **Chapter 9 - Limit theorems**: Convergence modes (convergence in probability, almost sure convergence, convergence in distribution), law of large numbers and central limit theorem. ($\sim$ 1.5 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.