**MATH2421 Probability**

**Course Outline-Spring 2025**

## 1. Instructor(s)

*Name: Ke Wang*

*Contact Details: Room 3434 & 3469-2016, kewang@ust.hk*

## 2. Teaching Assistant(s)

*Name: CHEONG, Kha Man*

*Contact Details: kmcheong@connect.ust.hk*

## 3. Meeting Time and Venue

*Lectures:*

**Date/Time:** L1 Mon/Wed (12:00 - 13:20); L2 Tue/Thu (9:00 - 10:20)

**Venue:** L1 (5583, Lift 29-30); L2 (4620, Lift 31-32)

*Tutorials:*

**Section/Date/Time/Venue:**

T1A, Th 05:00PM - 05:50PM, G009B, CYT Bldg

T1B, We 02:00PM - 02:50PM, Rm 4502, Lift 25-26

T2A, Mo 09:30AM - 10:20AM, Rm 4579, Lift 27-28

T2B, We 04:00PM - 04:50PM, Rm 2306, Lift 17-18

## 4. Course Description

Credit Points: 4

Pre-requisite: MATH 1014 OR MATH 1020 OR MATH 1024

Exclusion: EDA 2510, IEDA 2520, MATH 2431, EEC 2600, ELEC 2600H, ISOM 3540

Brief Information/synopsis: The course covers the basic principles of probability theory. Topics include combinatorial analysis used in computing probabilities, the axioms of probability, conditional probability and independence of events, discrete and continuous random variables; joint, marginal, and conditional densities, moment generating function; binomial, Poisson, gamma, exponential, Gamma, Beta, Cauchy, univariate, and bivariate normal distributions; laws of large numbers; central limit theorem.

## 5. Intended Learning Outcomes

Upon successful completion of this course, students should be able to:

| No. | ILOs |
|---|---|
| 1 | Recognize and use appropriately important technical terms and definitions. |

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|---|---|
| 2 | Use axioms of probability to calculate various probabilities. |
| 3 | Understand discrete and continuous random variables and associate them with various random experiments. |
| 4 | Solve real and hypothetical problems using the laws of large numbers and central limit theorem. |

## 6. Assessment and Grading

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.

**Assessments:**

| Assessment Task | Contribution to Overall Course grade (%) | Due date (if applicable) |
|---|---|---|
| Homework | 15% | Will be announced in Canvas |
| Midterm | 35% | TBD |
| Final Exam | 50% | TBD |

Assessment marks for individual assessed tasks will be released within two weeks of the due date.

**Mapping of Course ILOs to Assessment Tasks**

| Assessed Task | Mapped ILOs | Explanation |
|---|---|---|
| Homework | ILO1, ILO2, ILO3, ILO4 | The homework assesses students' ability of understanding the concepts and the logic, distilling the abstract setting from examples, and applying the theory to other fields. |
| Midterm | ILO1, ILO2, ILO3, ILO4 | The mid-term exam assesses students' ability of understanding the concepts and the logic, distilling the |

| | | |
|---|---|---|
| | | abstract setting from examples, and applying the theory to other fields. |
| Final Exam | ILO1, ILO2, ILO3, ILO4 | The final exam assesses students' ability of understanding the concepts and the logic, distilling the abstract setting from examples, and applying the theory to other fields. |

**Grading Rubrics**

Marks for each problem will be specified. Full marks will be awarded for completely correct answers. Partial credit will be given for answers that are on the right track but not fully complete.

**Final Grade Descriptors:**

| Grades | Short Description | Elaboration on subject grading description |
|---|---|---|
| A | Excellent Performance | The student has mastered almost all concepts and theories of functional analysis taught in the course, has excellent understanding of the deepest content of the subject, and acquired workable knowledge for further studies of partial differential equations. |
| B | Good Performance | The student has mastered most theories of functional analysis taught in the course, yet the understanding of some challenging concepts may not be deep enough for their applications on related advanced subjects. |

| | | |
|---|---|---|
| C | Satisfactory Performance | The student meets the minimum expectation of the instructor, has acquired some basic computational techniques of the subject but only in finite dimensions, yet some concepts were not clearly understood. |
| D | Marginal Pass | The student is only able to recall some fragments of topics and is able to complete some of the easiest computations. |
| F | Fail | The student does not have sufficient understanding of even some fragments of topics, and is not even able to complete some of the easiest computations even in finite dimensions. |

## 7. Course AI Policy

Students are allowed to consult any person (including the instructor, TA, classmates, friends outside HKUST) in any homework for ideas and hints, but are required to write up the solutions by themselves. You are required to **list the persons and references** you have consulted in every homework.

The use of ChatGPT or other generative AI is allowed, and they are regarded as "persons" you have consulted, and therefore must be listed in your homework.

However, please be warned that at the current stage of development of AI, the response to problems in advanced courses – especially those in pure mathematics – is not quite reliable. Students should be critical of the response generated by AI and do not blindly copy the generated responses to your homework.

## 8. Student Learning Resources

Recommended Reading:

Textbook:

Sheldon M. Ross, "A First Course in Probability", Pearson.

## 9. Teaching and Learning Activities

Scheduled activities: 4 hrs (lecture + tutorial)

**10. Course Schedule**

| | |
|---|---|
| Week 1 | Chapter 1: Principle of counting, permutations |
| Week 2 | Chapter 1: Combinations, Multinomial coefficients, number of integer solutions Chapter 2: Sample spaces and events |
| Week 3 | Chapter 2: Operations on events, axioms of probability, properties of probability, Sample spaces having equally likely outcomes |
| Week 4 | Chapter 3: Conditional probability, total probability, Bayes' Theorem, independence |
| Week 5 | Chapter 4: Definition of random variables, discrete random variables, expected values, expectation of a function of a random variable, variance and standard deviation |
| Week 6 | Chapter 4: Discrete random variables arising from repeated trials, Poisson random variable, hypergeometric random variable, expected value of sum of random variables |
| Week 7 (Midterm)<br>Week 8 | Chapter 5: Continuous random variables, probability density function, expectation and variance, uniform distribution, normal distribution, exponential distribution, Gamma distribution |
| Week 9 | Chapter 5: Beta distribution, Cauchy distribution, approximations of binomial random variables, distribution of a function of a random variable |
| Week 10 | Chapter 6: Joint distribution functions, independent random variables, sum of independent random variables, conditional distributions |
| Week 11 | Chapter 6: Joint probability distribution function of functions of random variables Chapter 7: Expectation of sum of random variables, covariance/variance of sums and correlation |
| Week 12 | Chapter 7: Conditional expectation, conditional variance, moment generating function, joint moment generating functions |
| Week 13 | Chapter 8: Chebyshev's inequality and weak law of large numbers, strong law of large numbers, Central limit theorem |

**11. Communication and Feedback**

Assessment marks for individual assessed tasks will be communicated via Canvas within two weeks of submission. Feedback on assignments will include [specific details, e.g., strengths, areas for improvement]. Students who have further questions about the feedback including marks should consult the instructor within five working days after the feedback is received.

**12. Academic Integrity**

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