The Hong Kong University of Science and Technology (Guangzhou)

FTEC 2120 Probability Syllabus

[Course Title] **Probability**

[Course Code] **FTEC 2120**

[No. of Credits] **4**

[Any pre-/co-requisites] **General Calculus I or Honor Calculus I and II, Linear Algebra preferred.**

1. Name and Office Hour of Instructor

Instructor: Xiaoyu Wang, xiaoyuwang@hkust-gz.edu.cn.

Office Hour: W1-306, by appointment.

2. Lecture (Tutorial) Day, Time, and Venue

Lectures: Monday and Wednesday 9:00am - 10:20am; W1-222.

Tutorials: Monday 6:00pm – 6:50pm; W2-201.

【The above information is subject to the latest updates on Canvas.】

Course Description

Topics: The schedule might be adjusted.

Part I (Concepts): (1). Probability space; (2). Propositions of probability; (3). Conditional probability and independence.

Part II (Fundamentals): (4). Random variables and probability distributions; (5). Jointly distributed random variables; (6). Expectation, variance and conditional expectation.

Part III (Advanced): (10). Characteristic function* and limit theorems; (11). Modes of convergence*.

*Topics marked with an asterisk will be covered subject to time availability.

Intended Learning Outcomes (ILOs)

By the end of this course, students should be able to:

1. Recognize and use appropriately important technical terms and definitions.

2. Use axioms of probability to calculate various probabilities.

3. Understand discrete and continuous random variables and be able to associate them with various random experiments in the real world.

4. Understand joint distribution, marginal distribution and be able to derive them by using theorems.

5. Understand laws of large numbers and central limit theorem and be able to solve real and hypothetical problems using the laws of large numbers and central limit theorem.

Weekly Schedule & Weekly ILOs

Week #	Topics	Weekly ILOs
1	Probability space. Definition of probability. Frequency interpretation; zero-probability events.	Understand the concept of probability as a mathematical model. Distinguish axiomatic probability from empirical frequency. Explain the meaning of zero-probability events. ILO-1, ILO-2.
2	Basic properties of probability. Additivity. Continuity of probability.	Apply fundamental properties of probability. Compute probabilities using set operations. Understand continuity from above and below. ILO-1, ILO-2.
3	Conditional probability. Independence.	Compute conditional probabilities. Determine independence between events. Interpret independence conceptually and mathematically. ILO-1, ILO-2.
4	Law of total probability. Bayes' formula. Introduction to random variables.	Use Bayes' theorem to update probabilities. Understand random variables as numerical descriptions of random outcomes. ILO-1, ILO-2, ILO-3.
5	Discrete random variables. Cumulative distribution function. Expectation and Variance. Bernoulli and Binomial distributions.	Compute distributions, expectations, and variances of discrete random variables. Model repeated experiments using Bernoulli and Binomial distributions. ILO-1, ILO-2, ILO-3.
6	Poisson distribution. Binomial–Poisson approximation. Rare events.	Model rare events using the Poisson distribution. Apply approximation techniques. Interpret real-world counting processes. ILO-1, ILO-2, ILO-3.
7	Hypergeometric, Geometric, and Negative Binomial distributions.	Distinguish between samplings with and without replacement. Model waiting-time problems. ILO-1, ILO-2, ILO-3.
8 (Midterm)	Continuous random variables. Density functions. Uniform and Exponential distributions.	Understand probability density functions. Compute probabilities and expectations for continuous random variables. Model lifetimes, waiting times. ILO-1, ILO-2, ILO-3.

9	Normal distribution. Distributional approximations. Gamma distribution.	Explain the role of the normal distribution. Understand Gamma distribution and its applications. ILO-1, ILO-2, ILO-3.
10	Properties of CDFs. Transformations of random variables. Quantiles.	Analyze distributions using CDF properties. Compute distributions of transformed variables. Interpret quantiles and risk measures. ILO-1, ILO-2, ILO-3.
11	Joint distributions. Discrete and continuous random vectors. Marginal distributions.	Work with joint distributions. Compute marginal distributions. Understand dependence structures between random variables. ILO-1, ILO-2, ILO-3, ILO-4.
12	Independence in higher dimensions. Conditional distributions. Bivariate normal distribution.	Analyze multivariate dependence. Compute conditional distributions. Understand properties of the bivariate normal model. ILO-1, ILO-2, ILO-3, ILO-4.
13	Expectation and conditional expectation. Characteristic functions. Limit theorems.	Apply properties of expectation and conditional expectation. Use characteristic functions. Understand law of large numbers and central limit theorems. ILO-1, ILO-2, ILO-3, ILO-5.

Assessment and Grading

The grading is assigned based on students' performance in assessment tasks/activities.

Examination duration: Midterm exam 80mins; final exam 2 hrs.

Assessments:

Assessment Task	Contribution to Overall Course grade (%)	Due date
Mid-term exam	35%	TBA, uniform across sessions
Final exam	50%	TBA, uniform across sessions
Assignments	15%	TBA, may vary by sessions

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

Grading Rubrics

This course utilizes an absolute grading system as follows and grades will not be assigned using a curve.

A: [100,85]; B: (85,70]; C: (70,55]; D: (55,35]; F: (35,0].

Subgrades (e.g., A-, B+, etc.) will be assigned for every 5 points within these ranges.

Mapping of Course ILOs to Assessment Tasks

Assessed Task	Mapped ILOs	Explanation
Mid-term exam	ILOs 1-3, Weekly ILOs 1-7	The mid-term exam will be used to assess students' understanding and skills in Part I (1)(2)(3) and Part II (4).
Final exam	ILOs 1-5, Weekly ILOs 1-13	The final exam will be used to assess students' understanding and skills in Part I, Part II and Part III.
Assignments	ILOs 1-5, Weekly ILOs 1-13	These tasks are designed to assess students' abilities, comprehension, and dedication in learning and understanding of probability.

Final Grade Descriptors:

Grades	Short Description	Elaboration on subject grading description
A	Excellent Performance	Demonstrates a comprehensive analysis and applications of probability theories in problem-solving, mathematical proofs, and significant creativity in thinking. Exhibits a high capacity for scholarship going beyond core requirements to achieve learning goals.
B	Good Performance	Shows good knowledge and understanding of the main subject in probability, competence in problem-solving, mathematical proofs, and the ability to analyze and evaluate issues. Displays high motivation to learn this course.
C	Satisfactory Performance	Possesses adequate knowledge of probability, competence in dealing with familiar problems, and some capacity for analysis and critical thinking. Shows persistence and effort to achieve broadly defined learning goals.
D	Marginal Pass	Has threshold knowledge of core subject matter, potential to achieve key professional skills, and the ability to make basic judgments. Benefits from the course and has the potential to develop in the discipline.
F	Fail	Demonstrates insufficient understanding of probability and lacks the necessary problem-solving skills. Shows limited ability to think critically or analytically and exhibits minimal effort towards achieving learning goals. Does not meet the threshold requirements for professional practice or development in the discipline.

Course AI Policy

The direct use of generative artificial intelligence (AI) tools in examinations or assignments is typically prohibited.

This is because these tools can produce detailed responses and solutions without the user demonstrating their own understanding or problem-solving process. The purpose of exams and assignments is to assess the individual's knowledge, comprehension, and ability to apply what they have learned. Using AI tools circumvents this process, undermining the educational objectives of developing critical thinking, problem-solving skills, and deep understanding of the course materials. It's allowed for students to use such AI tools only as supplementary aids, if permitted, for learning and not for assessment purposes.

Communication and Feedback

Each assignment can only be submitted and assessed once, emphasizing the importance of diligence and thoroughness in initial attempts. For students who seek clarification or have concerns regarding their exam scores, it is imperative to initiate communication with the instructor within a specified timeframe—**five working days from the receipt of their grades**. This prompt action ensures that any discrepancies or misunderstandings can be addressed in a timely manner.

Resubmission Policy

The decision to grant a reassessment opportunity for a student's exam performance rests solely with the instructor. This discretion allows instructors to consider the individual circumstances surrounding a student's request, such as the nature of any errors or misunderstandings in the initial assessment, the student's overall performance and engagement in the course, and the policies of the academic institution. It underscores the importance of the instructor's role not only in evaluating academic performance but also in fostering a fair and supportive learning environment where students feel their concerns are heard and addressed appropriately.

References:

[1]. (Textbook) Ross (2020). A first course in probability, 9th (or 10th) edition. Harlow, UK: Pearson.

[2]. Chung (2000). A course in probability theory. Elsevier.

[3]. Bogachev (2007). Measure theory. Berlin: springer.

Academic Integrity

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