Annexe A: New/Revised Course Content in OBTL+ Format

Course Overview

Expected Implementation in Academic Year	AY2025-2026
Semester/Trimester/Others (specify approx. Start/End date)	Semester 1
Course Author * Faculty proposing/revising the course	Wu Guohua
Course Author Email	guohua@ntu.edu.sg
Course Title	Probability
Course Code	MH2500
Academic Units	4
Contact Hours	51
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	MH1100 AND MH1101 OR MH1800 AND MH1801 OR MH1101 AND MH110S OR MH1100 AND MH111S OR MH1802 OR CY1601 OR MH1805
Co-requisites	
Pre-requisite to	
Mutually exclusive to	MH1820, MH2814, SC2000
Replacement course to	
Remarks (if any)	

Course Aims

This is a core mathematical course, aiming to develop your understanding of fundamental concepts in probability such as random variables, independence, basic probability distributions, and conditional expectations and conditional variances, the law of large numbers and the central limit theorem with applications. The course also prepares you for further courses in probability and statistics, such as MH2510, MH3500 and MH3512.

Course's Intended Learning Outcomes (ILOs)

Upon the successful completion of this course, you (student) would be able to:

ILO 1	Calculate probabilities of events concerning discrete distributions by counting
ILO 2	Calculate conditional probabilities with Bayes Theorem
ILO 3	Describe a probability distribution using cdf/pdf, including joint and marginal distributions
ILO 4	Identify the scenarios which certain probability distributions are appropriate to model
ILO 5	Calculate the expectation/variance/mg/quantiles of a probability distribution/random variable, including marginal distributions
ILO 6	Calculate the distribution of functions of random variables (especially the sum and quotient of two random variables) and the covariance of two random variables
ILO 7	Prove or disprove that two random variables are independent
ILO 8	Calculate conditional expectations and conditional variances
ILO 9	Explain central limit theorem and its significance, and apply central limit theorem to approximate the probability of event concerning a sum of random variables

Course Content

Events, probabilities, law of total probability, Bayes theorem

Independence events

Discrete distributions, continuous distributions

Joint distribution, marginal and conditional distribution for discrete variables

Joint distribution, marginal and conditional distribution for continuous variables

Functions of two or more random variables, order statistics, exponential distribution

Expectation, variance,

Covariance, correlation coefficient

Markov inequality, Chebyshev inequality

Conditional expectations, conditional variances and moment generating functions

Law of large numbers, central limit theorem with applications

Reading and References (if applicable)

Textbook: [R1] Sheldon Ross. A First Course in Probability. Pearson, 2020. (10th edition. ISBN: 978-0134753119)

NOTE: The above listing comprises the foundational readings for the course and more up-to-date relevant readings will be provided when they are available.

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
1	Events, probabilities, law of total probability, Bayes theorem	1, 2, 6, 7	[R1] §2.1-2.5, §3.1-3.2, 3.5	In-person	
2	Independence events, discrete distributions	3, 4	[R1] §3.3-3.4	In-person	
3	discrete random variables	3-5	[R1] §4.1-4.2	In-person	
4	discrete random variables	3-5	[R1] §4.1-4.2	In-person	Test 1
5	discrete random variables	3-5	[R1] §4.7-4.10	In-person	
6	continuous random variables	3, 6, 7	[R1] §5.1-5.4	In-person	
7	continuous random variables	3, 6, 7	[R1] §5.5-5.6	In-person	
8	jointly distributed random variables	3, 6, 7	[R1] §6.1-6.3	In-person	
9	jointly distributed random variables	6	[R1] §6.4-6.6	In-person	
10	expectations involving multiple random variables	5-6	[R1] §7.1-7.4	In-person	Test 2

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
11	covariance and correlation coefficients	5-6	[R1] §7.5-7.8	In-person	
12	Law of large numbers, central limit theorem	8	[R1] §8.1-8.4	In-person	
13	applications of central limit theorem	9	[R2] §9.1-9.3	In-person	

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Lectures	Help you to understand the motivation and definitions of the concepts and notions, approaches to solving the problems in pursuant to learning outcomes
Tutorials	Develop communication and presentation skills, help you to understand better the concepts and notions, and techniques in problem solving

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Description of Assessment Component	Team/Individual	Rubrics	Level of Understanding
1	Continuous Assessment (CA): Test/Quiz(Test 1)	1, 2, 3, 5		20		Individual	Analytic	Relational
2	Continuous Assessment (CA): Test/Quiz(Test 2)	5, 6, 7		20		Individual	Analytic	Relational
3	Summative Assessment (EXAM): Final exam(Short Answer Questions)	1, 2, 3, 4, 5, 6, 7, 8, 9		50		Individual	Analytic	Multistructural
4	Continuous Assessment (CA): Class Participation(Short Answer Questions)	1, 2, 3, 4, 5, 7, 8, 9		10		Individual	Holistic	Relational

Description of Assessment Components (if applicable)

The CA part consists of Test 1, Test 2 and Class Participation, and the two tests are allocated in Week 4 and Week 10 correspondingly. Topics covered in Test 1 are basics of probability, conditional probability and Bayes theorem. Test 2 covers marginal distribution, joint distribution, expectation, variance. The part of class participation will be conducted in the tutorials, where students are required to answer short questions. CA will contribute 50% to the assessment.

The Exam covers all topics of this course. The exam contributes 50% to the assessment.

Formative Feedback

Feedback will be given after each midterm on common mistakes and level of difficulty of the problems. For the final exam, comments on answers and common errors will also be given to students after the exams are marked. Feedback can also be given through discussion within tutorial lessons.

NTU Graduate Attributes/Competency Mapping

This course intends to develop the following graduate attributes and competencies (maximum 5 most relevant)

Attributes/Competency	Level
Adaptability	Advanced
Curiosity	Advanced
Critical Thinking	Advanced

Course Policy

Policy (Academic Integrity)

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values. As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. On the use of technological tools (such as Generative AI tools), different courses / assignments have different intended learning outcomes. Students should refer to the specific assignment instructions on their use and requirements and/or consult your instructors on how you can use these tools to help your learning. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Policy (General)

You are expected to attend all classes punctually and take all scheduled tutorials and tests by due dates. You are expected to take responsibility to follow up with course notes, assignments and course related announcements. You are expected to participate in all discussions, presentations and activities. You are expected to attend the midterms. In case of medical leaves, you should provide a satisfying medical certificate on time.

Policy (Absenteeism)

Absence due to medical or other reasons. If you are sick and unable to attend a test you must:

1. Send an email to the instructor regarding the absence.
2. Submit the original Medical Certificate to an administrator.

The Medical Certificate mentioned above should be issued in Singapore by a medical practitioner registered with the Singapore Medical Association. There will be make-up opportunity for students who are absent from the tests with valid reason.

Policy (Others, if applicable)

Diversity and inclusion policy

Integrating a diverse set of experiences is important for a more comprehensive understanding of science.

It is our goal to create an inclusive and collaborative learning environment that supports a diversity of perspectives and learning experiences, and that honours your identities; including ethnicity, gender, socioeconomic status, sexual orientation, religion or ability.

To help accomplish this:
• If you are neuroatypical or neurodiverse, have dyslexia or ADHD (for example), or have a social anxiety disorder or social phobia;

- If you feel like your performance in the class is being impacted by your experiences outside of class;
- If something was said in class (by anyone, including the instructor) that made you feel uncomfortable;

Please speak to your teaching team, our school pastoral officer or a peer or senior (either in-person or via email) about how we can help facilitate your learning experience.

As a participant in course discussions, you should also strive to honour the diversity of your classmates. You can do this by: using preferred pronouns and names; being respectful of others opinions and actively making sure all voices are being heard; and refraining from the use of derogatory or demeaning speech or actions.

All members of the class are expected to adhere to the NTU anti-harassment policy. if you witness something that goes against this or have any other concerns, please speak to your instructors or a faculty member.

Appendix 1: Assessment Rubrics

Rubric for Tutorials: Participation and Short Answer Questions (10%)

Criteria	Standards		
	Fail standard (0-5)	Pass standard (6-8)	High standard (9-10)
Participation And Short Answer Questions	Lack participation or unsatisfactory answers to short questions	Enough participation and provide satisfactory answers to short questions	Active participations, and provide correct answers to short questions

Rubric for Tests: Test 1 (20%, point-based marking)

Criteria	Standards		
	Fail standard	Pass standard	High standard
Methods of approach	Using methods that are irrelevant or do not apply to the given problem. Invoking theorems whose conditions are not satisfied.	Using relevant methods that help solve the problem. Invoking theorems whose conditions are satisfied.	Finding methods and utilizing theorems that are both relevant and effective
Validity of reasoning	Reasoning is logically invalid.	Reasoning is logically valid.	Reasoning is logically valid and effective.
Clarity of argument	Reasoning is poorly explained or not explained at all.	Reasoning is clear but may contain some gaps.	Reasoning is clear, precise with no or insignificant gaps.

Rubric for Tests: Test 2 (20%, point-based marking)

Criteria	Standards		
	Fail standard	Pass standard	High standard
Methods of approach	Using methods that are irrelevant or do not apply to the given problem. Invoking theorems whose conditions are not satisfied.	Using relevant methods that help solve the problem. Invoking theorems whose conditions are satisfied.	Finding methods and utilizing theorems that are both relevant and effective
Validity of reasoning	Reasoning is logically invalid.	Reasoning is logically valid.	Reasoning is logically valid and effective.
Clarity of argument	Reasoning is poorly explained or not explained at all.	Reasoning is clear but may contain some gaps.	Reasoning is clear, precise with no or insignificant gaps.

Rubric for Examination: Final Exam (50%, point-based marking)

Criteria	Standards		
	Fail standard	Pass standard	High standard
Methods of approach	Using methods that are irrelevant or do not apply to the given problem. Invoking theorems whose conditions are not satisfied.	Using relevant methods that help solve the problem. Invoking theorems whose conditions are satisfied.	Finding methods and utilizing theorems that are both relevant and effective
Validity of reasoning	Reasoning is logically invalid.	Reasoning is logically valid.	Reasoning is logically valid and effective.
Clarity of argument	Reasoning is poorly explained or not explained at all.	Reasoning is clear but may contain some gaps.	Reasoning is clear, precise with no or insignificant gaps.