MATH4427 Loss Models and Their Applications
Course Outline
Fall Semester 2025-2026

1. Instructor:

Name: Dr. Leung Chi Man (You may call me LCM if you wish)
Office: Room 3419 (Lift 17-18)
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Office Tel: 34693033
Office Hours: Every Friday 6:00 p.m.- 7:30 p.m. (@Room 3420)

2. Meeting time and Venue

Lectures: (Mons) 4:30p.m.-6:50p.m. @Room 1527 (Lift 22)
(Fri) 12:00p.m.-1:20p.m. @Room 1527 (Lift 22)
(*Note 1: The tutorial on Monday will also be used as lecture.)
(*Note 2: The classes will be conducted in face-to-face mode. There is no attendance policy in this course. However, all students are expected to attend the classes)

3. Course Description

Credit point: 3 credits
The key objective in this course is to explore how to construct a mathematical model to study the risk management problem faced by an insurance company. During the process, you are going to learn how do probability theory and statistical theory that you learnt from earlier courses be applied in practice.

- In the first part of this course, we first construct a simple model (severity model, frequency model and aggregate loss model) for studying the losses faced by the company. We also study the probability tools needed in studying the target.
- In the second part of this course, we shall study how to fit the model with the actual data. The analysis requires a lot of statistical analysis including elementary point estimation, interval estimation and hypothesis testing. Lastly, we also examine how to evaluate the entire model in the sense that whether the given model is consistent with the actual data in reality.

Additional note (For those who consider taking SOA exams)
This course will cover

- 70% of the content covered in FAM (FAM-S component) exam and ASTAM exam offered by the Society of Actuaries (SOA).

Prerequisites: Since this course is an advanced course in actuarial mathematics and is very ~~**difficult**~~ **exciting**, we expect that all students should have solid background in basic calculus/multivariable calculus (MATH2023), probability and statistical theory (MATH2411 + MATH2421), elementary financial knowledge and good knowledge in actuarial maths (MATH2511). Some knowledge in mathematical analysis (MATH2033), is also helpful but it is not essential.

4. Intended Learning Outcome (ILOs)

(Quoted from Learning Outcome in SOA STAM Exam syllabus)

1. Upon successful completion of this course, students are expected to be familiar with severity, frequency and aggregate models, and use statistical methods to estimate parameters of such models given sample data. Students are expected to identify steps in modelling process, understand the underlying assumptions implicit in each family of models, recognize which assumptions are applicable in a given business application, and appropriately adjust models for impact of insurance coverage modifications.

5. Student Learning Resources

We will use our own Lecture notes in this course. Additional problem sets (optional) will be provided. The materials can be downloaded from https://canvas.ust.hk once they are available.

The following reference books will be useful:

1. Klgman, Panjer and Wilmot, 2012, "Loss models: From data to decisions", 4th edition, SOA.
   (*This is also a textbook recommended by SOA for their SOA exams. Earlier edition of this book can be borrowed from HKUST library. Alternatively, borrow the book via HKALL.)

2. Brown, R.L., Gottlieb, L.R., "Introduction to ratemaking and loss reserving for property and casualty insurance", 3rd edition, ACTEX.

6. Teaching and Learning Activities

Lectures (4 hours per week)

7. Tentative Course Schedules

Chapter 1: A quick review on basic probability theory

- Basic review on random variables
- Expected, moments, skewness and kurtosis
- Moment generating function, probability generating function and characteristic function

Chapter 2: Severity Model, Frequency Model and coverage modification

- Probability distributions for claim severity and claim frequency.
- Criterions in selecting models for claim severity and claim frequency
- Coverage modifications: Deductible, policy limit, maximum covered loss and coinsurance. Effect of coverage modification on claim payment.

Chapter 3: Aggregate Loss models

- Models for aggregate claims: Collective Risk Model and Individual Risk Model
- Computing the aggregate claims distribution
- Effect of individual policy modifications on aggregate payments
- Risk measures: VaR (Value-at-risk) and TVaR
- Reinsurance and stop-loss premium

Chapter 4: Parameter estimation in parametric model

- Basics in parameter estimation
- Method of moment and percentile matching
- Maximum likelihood method: Complete data, Grouped data and truncated/censored data.
- Variance and interval estimation of maximum likelihood estimator (Harder)
- Introduction to Delta method.
- Bayesian Analysis: An introduction.

Chapter 5: Additional topic: Premium calculation and risk management in non-life insurance (If time allowed)

- Basic principle of premium calculation and ratemaking
- Basic idea of loss reserving
- Methods of loss reserving: Expected Loss Ratio (ELR) method, Chain Ladder (CL) Method, Bornhuetter-Fergusin (BF) Method etc.

8. Assessment Scheme

There are 3 assessment tasks in this course:

	Weight	CILOs assessed
Assignment	15% + Bonus	1
Midterm Examination	25%	1
Final examination	60%	1

(a) Assignment (15% of the total grade + Bonus)

There are required problems and optional problems in each of the assignments. You are required to complete all required problems. Also, you may complete some of the optional problems for bonus score (which may improve your final grade).

(b) In-class midterm examination (25% of the total grade)

Date: 20th Oct, 2025 (Monday)

Time: 4:30p.m.-6:30p.m. (Class hours)

It will be an in-class closed-book midterm and covers the materials taught before the midterm. The exact coverage of the midterm exam will be announced around 1 week before the midterm exam.

(*No external cheat sheet/ formula sheet is allowed)

(c) Final Examination (60% of the total grade)

It is a 3 hours closed book on campus exam. The final exam will cover all materials (including proof) covered in the course. The date and venue of the final exam will be confirmed by ARR. The detailed arrangement of the exam will be announced later.

(*No external cheat sheet/ formula sheet is allowed)

Grading Policy

We will adopt criterion-referencing scheme when assigning your final grade: Your final grade will be assigned based on your overall performance in this course only.

- You are guaranteed to pass the course if you obtain at least **40%** in overall total (including bonus score). And your minimum grade will be C-.
- You are guaranteed to get B- or above if you obtain at least **60%** in overall total (including bonus score).
- You are guaranteed to get A- or above if you obtain at least **80%** in overall total (including bonus score).

Grade Descriptors:

Letter Grades	Short Description	Elaboration of subject grading description
A+/A/A-	Excellent Performance	The student has mastered all knowledge and techniques on loss models. In particular, the student is able to understand all concepts taught and is able to apply those knowledge in solving various real life problems in short-term insurance.
B+/B/B-	Good Performance	The student has good understanding on knowledge and techniques on loss models. The student is able to apply the knowledge in solving some common real life problems related to short-term insurance.
C+/C/C-	Satisfactory Performance	The student meets the minimum expectation of the instructor: He has acquired good understanding on basic concepts and techniques involved in loss models. In addition, the student is able to apply the basic knowledge in solving some simple real life problems related to short-term insurance.
D	Marginal Pass	The student only know some very basic concepts in loss models. He is able to complete some simple calculation only.
F	Fail	The student has very limited understanding about the concepts in loss models which is not sufficient for solving problems in loss models

9. AI policy in this course

You are prohibited from using generative artificial intelligence (AI) to produce any materials or content related to the assessment task. You are expected to complete all assignments with your own effort.