MATH 4360 Mathematical Modeling

Course Outline – Spring Term 2025/2026

1. Instructor: MATH 4360 by Professor ***Tiezheng QIAN***

Email: maqian@ust.hk **Office**: Room 3437

Office hours: Appointments via email

2. Lecture & Tutorial:

MATH4360	Mathematical Modeling	QIAN, Tiezheng/maqian	L1	Mon/Wed	10:30 - 11:50	4580	40
		TA: ZHANG, Wenlin/wzhangdh Grader: OU, Guohui/ gouaa	T1A	Thu	14:00 - 14:50	4504	40

3. COURSE DESCRIPTION

Credits: 3

Mechanical Vibrations, Population Dynamics — Mathematical Ecology, Traffic Flow, Random Walk and Diffusion, Principles of Mathematical Modeling.

Exclusion: N.A.

Pre-requisite: MATH 2350 OR MATH 2351 OR MATH 2352

4. INTENDED LEARNING OUTCOMES (ILOs)

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

1	Understand the foundations of mathematical modeling, including principles, methods, dimensional analysis, scale, approximation, and model validation.
2	Understand a range of mathematical models built in a range of disciplines, with a focus on mechanical vibrations, population dynamics, and traffic flow.
3	Solve problems by building mathematical models, carrying out theoretical analysis, and performing numerical computation.
4	Develop experiences in and familiarity with analysis and computation skills for mathematical models.
5	Develop mathematical maturity to undertake higher level studies in mathematics and related fields.

5. ASSESSMENT SCHEME (to be updated)

30% Homework: Course ILOs: 1, 2, 3, 4, 5

30% Two to Three Quizzes (of equal weights): Course ILOs: 1, 2, 3, 4, 5

40% Final Exam: Course ILOs: 1, 2, 3, 4, 5

The final exam is comprehensive, i.e., all the materials taught in the whole semester will be tested, including those already tested in the midterm exam. But **focus** will be on those topics not covered in the midterm.

Closed-book exams: No notes and no calculators. More information will be given prior to the exams.

5.1 Letter Grades

Students should aim at getting a **course total** of 75% or above for A-/A/A+, and about 50% or above for B-/B/B+.

5.2 Grade Descriptors

Grade A — *Excellent Performance*: The student has mastered almost all concepts and techniques of the topics covered in the course and has acquired workable knowledge for further and deeper studies.

Grade B — *Good Performance*: The student has mastered a good part of concepts and techniques of the topics covered in the course, yet the understanding of some challenging concepts may not be deep enough for further studies on related advanced subjects.

Grade C — *Satisfactory Performance*: The student meets the minimum expectation of the instructor by acquiring some basic computational techniques of the subject, yet some concepts were not clearly understood.

Grade D — *Marginal Pass*: The student can only recall some fragmented topics and complete some easiest computations.

Grade F — *Fail*: The student cannot even recall some fragmented topics and complete some easiest computations.

6. Student Learning Resources

Textbook: ***Mathematical Models: Mechanical Vibrations, Population Dynamics, and Traffic Flow*** (Classics in Applied Mathematics, Series Number 21) by Richard Haberman (Author)

Reference: ***Principles of Mathematical Modeling*** 2nd Edition by Clive Dym (Author)

The course materials will be provided from a variety of resources. *No specific textbook is required for this course*. Lecture notes will be uploaded to the course's Canvas page on a regular basis.

7. Teaching and learning Activities

Scheduled activities: 4 hours (Lecture for 3 hours & Tutorial for 1 hour) per week

8. TEACHING SCHEDULE (with flexibility)

Topic 1.	**Mechanical Vibrations**	**~ 4 classes**
Topic 2.	**Population Dynamics — Mathematical Ecology**	**~ 4 classes**
Topic 3.	**Traffic Flow**	**~ 4 classes**
Topic 4.	**Random Walk and Diffusion**	**~ 4 classes**
Topic 5.	**Perturbation Methods**	**~ 5 classes**
Topic 6.	**Principles of Mathematical Modeling**	**~ 4 classes**

9. 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 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.

10. 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.

Additional information — Rationale for introducing this course

There are three reasons for introducing this course. Firstly, knowledge of mathematical modeling is *essential* to Applied

Mathematics students. This course provides them with an opportunity to gain *introductory yet comprehensive training in mathematical modeling*, from foundations to many applications. Secondly, being a traditional component of applied mathematics, mathematical modeling has become increasingly important for students to treat and solve *real-world problems* which present more challenges and opportunities than ever before. Thirdly, this course helps students be better prepared for a more advanced and challenging *career in the future*, from academia to industry.