

# Lecture 0

## Mathematical Modeling

Prof. Dr. Jingzhi Li

Department of Mathematics,  
Southern University of Science and Technology

2025 Spring



## ① Warming-up

## ② About me

## ③ What is Mathematical Modeling?

## ④ Research Journals

## ⑤ About this course

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# Warming-up

- Writing via Latex
  - Sharelatex registration
  - Texlive installation
  - Markdown
- Programming
  - Matlab registration & installation
  - Python installation
  - Github
- AIGC

## Good Reasons to Take this Course

- Very interesting and intellectually satisfying subject.
- Mathematical modeling provides an interdisciplinary experience where data matters.
- For some, there is possible relevance to future career prospects.

## Good Reasons to Avoid this Course

- This is not a hard-core course on analysis, geometry or algebra, just an introduction of principles, writing skills and computational aspects in mathematical modeling.
- It is taught by an applied mathematician instead of a pure one.
- There is emerging evidence of a large math and CS research community emerging in modeling.
- We will not learn how to win the MCM but please be prepared for a sequence of contests.
- My understanding is biased toward MCMs in China and the US.

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# About me

- Jingzhi Li, Ph.D., Professor, Department of Mathematics
- B.S. in Math, M.S. in CS, WHU
- PhD in Math, CUHK
- Postdoc, ETH Zurich
- Assistant Prof., CAS
- Associate Prof., SUSTech
- Prof., SUSTech

## About me: Teaching

- 10+ years teaching Math. Modeling, Applied Math, Financial Math at SUSTech
- Graduate level:
  - FEM, Numerical PDE
- Undergraduate level:
  - Calculus, Linear Algebra, ODE, Math Modeling, Computational Finance, Numerical Analysis

## About me: Research

- **Inverse Problems in Math. Phys.:**
  - Development of a general framework for reconstructions in inverse scattering problems
  - Modeling of invisibility cloaks
- **Computational Finance:**
  - Efficient numerical solvers in computational finance
- **Numerical Methods for PDEs:**
  - Numerical analysis of effective methods for interfaces and boundary layers.

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# What is Mathematical Modeling?

A **mathematical model** is a description of a system using mathematical concepts and language. The process of developing a mathematical model is termed mathematical modeling.

Mathematical models are used in the natural sciences (such as physics, biology, earth science, chemistry) and engineering disciplines (such as computer science, electrical engineering), as well as in the social sciences (such as economics, psychology, sociology, political science). **From Wiki.**

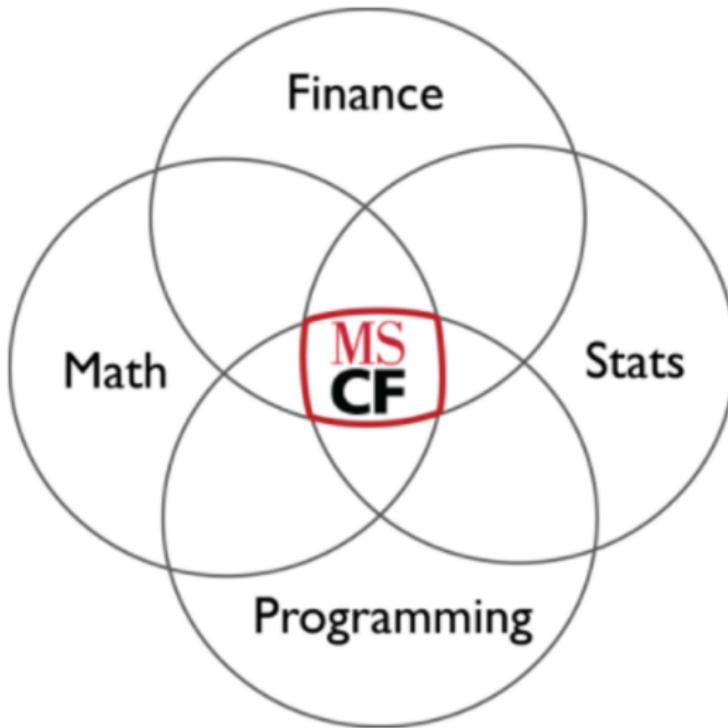


## Modeling vs. Modelling

Whether you're modelling or modeling, you're doing the same thing. The only difference is in the spelling—the one with the single L is preferred in the United States, while the one with two Ls is preferred everywhere else.



# Interdisciplinary subject



<https://mafm.ust.hk/>



# Admission requirements

<https://mafm.ust.hk/admission/admission-info>

## Admission Information

### Overview

We are looking for candidates with a solid background in undergraduate-level mathematics, statistics, finance, and computing.

Application Timeline (2020/21 Intake)	
1 Sep 2020	Applications open
1 Feb 2021 (23:59, GMT+8) <small>Updated</small>	Application deadline
TBC	Admission Interview/Exam
Jan to July 2020	Admission offers issued
1 Sep 2021	2021-22 Fall term commences

### Admission criteria

Applicants must hold a bachelor's degree in mathematics, engineering, physical sciences, or an equivalent qualification from a university or tertiary institution.

### English requirements

- Test of English as a Foreign Language (TOEFL)
  - Paper-based test (PBT) score of no less than 550
  - Internet-based test (IBT) score of no less than 80
- International English Language Testing System (IELTS)
  - overall score of 6.5 (raised from 6.0 previously) with no sub-score lower than 5.5
- You do not need to present TOEFL or IELTS score if
  - your first language is English, or



# Program Fee

## Application requirement

Please apply through the Online Admission System (OAS)  
(The 2020-21 Fall term commences on 1 September 2020)

## Application deadline

Please visit <http://pg.ust.hk> for information on admission requirements, admission timeline, and other information about postgraduate programs.

## Program Fee

The program fee for the 2021/22 Intake is HK\$210,000 for 36 credits.

## Living Expenses (Estimated)

Expenses per month	HKD\$
Accommodation (self-arranging)*	5,500
Food^	3,000
Books and supplies	1,000
Transportation	500
Total	10,000

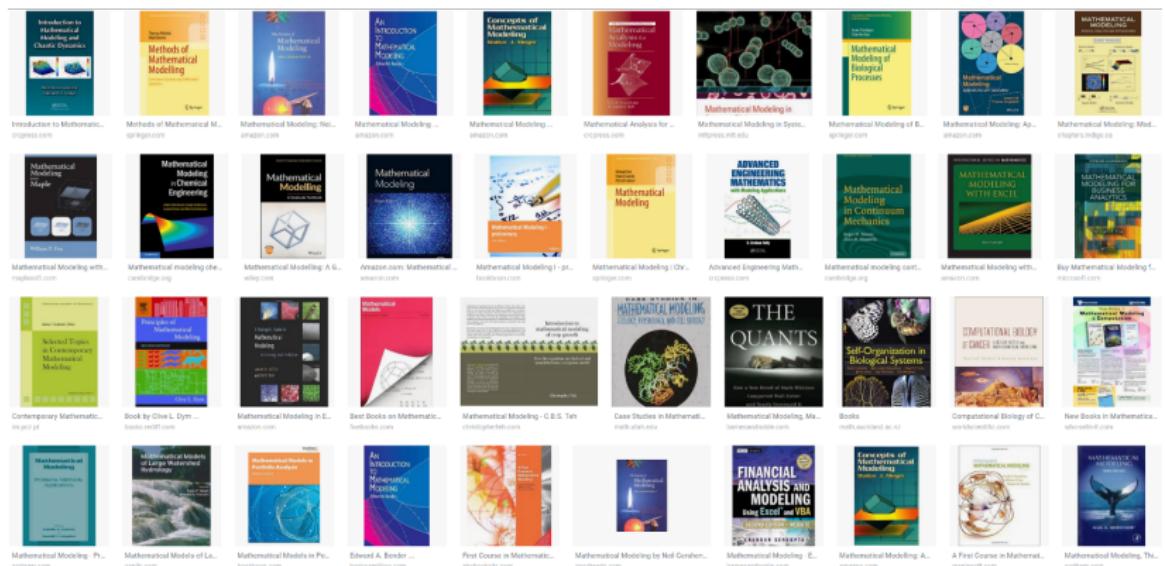
\* Accommodation standards and rents vary considerably

^ Calculations based on HK\$35/meal on campus

# Course List and Description

- + MAFS 5010 : Stochastic Calculus
- + MAFS 5020 : Advanced Probability and Statistics
- + MAFS 5030 : Quantitative Modeling of Derivatives Securities
- + MAFS 5040 : Quantitative Methods for Fixed-income Instruments
- + MAFS 5110 : Advanced Data Analysis with Statistical Programming
- + MAFS 5130 : Quantitative Analysis of Financial Time Series
- + MAFS 5140 : Statistical Methods in Quantitative Finance
- + MAFS 5210 : Mathematical Models of Investment
- + MAFS 5220 : Quantitative Risk Management
- + MAFS 5230 : Advanced Credit Risk Models
- + MAFS 5240 : Software Development with C++ for Quantitative Finance
- + MAFS 5250 : Computational Methods for Pricing Structured Products
- + MAFS 5260 : Building Financial Applications with Java and VBA
- + MAFS 5270 : Mathematical Market Microstructure
- + MAFS 5280 : Financial Markets in Hong Kong and China
- + MAFS5310 : Portfolio Optimization with R
- + MAFS 5330 : Structured Products - Analysis and Pricing
- + MAFS 5340 : Machine Learning and its Applications
- + MAFS6000 : Capstone Project in Financial Mathematics
- + MAFS6001 : Capstone Project II in Financial Mathematics
- + MATH 5520 : Interest Rate Models
- + MATH 5311 : Advanced Numerical Methods I
- + MAFS 6010 – Special Topics in Financial Mathematics (A Course Series)
- + MAFS 6010P : Distributed Ledger Technology and Financial Applications
- + MAFS6010U : Artificial Intelligence in Finance
- + MAFS6010W : Computing for Finance in Python
- + MAFS 6010X: Entrepreneurship and Venture Capital

# A glimpse of books on MM



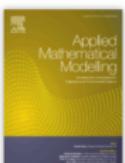
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# Journal of Mathematical Modeling



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**Journal of Mathematical Modeling**

Vol. 6, No. 2, Fall 2018 & Winter 2019  
available online at  
<http://www.jmm.sust.ac.ir>

**Articles in Press**

**Current Issue**

**Journal Archive**

**Volume 6 (2018)**

- Issue 2
- Issue 1

**Volume 5 (2017)**

- Volume 4 (2016)
- Volume 3 (2015)
- Volume 2 (2014)
- Volume 1 (2013)

**Journal of Mathematical Modeling (JMM)** publishes original high-quality peer-reviewed papers in all branches of computational or applied mathematics. It covers all areas of numerical analysis, numerical solutions of differential and integral equations, numerical linear algebra, optimization theory, approximation theory, control theory and fuzzy theory with applications, mathematical modeling in all major areas of applied sciences, computer simulation and parallel algorithms.

**SCOPUS** : JMM has been accepted for inclusion in SCOPUS. (23-Oct-2018)  
(See [Scopus](#))

**EBSCO** : JMM has been accepted for inclusion in EBSCO. (14-Jun-2018)

**Most Visited Articles**

- Determining the order of minimal realization of descriptor systems without use of the Weierstrass canonical form
- Residual norm steepest descent based iterative algorithms for Sylvester tensor equations
- Global least squares solution of matrix equation  $\sum_{j=1}^s A_j X_j B_j = E$
- Convergence of the multistage variational iteration method for solving a general system of ordinary differential equations
- On the optimal correction of inconsistent matrix equations  $AX = B$  and  $XC = D$  with orthogonal constraint

Current Issue: Volume 6, Issue 2, Summer and Autumn 2018 [XML](#)

**Research Paper**

1  A new outlier detection method for high dimensional fuzzy databases based on LOF  
Page 123-136  
Alireza Fakharzadeh Jahromi; Zahra Ebrahimi Mirand  
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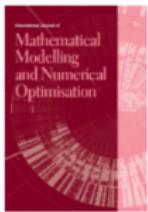
**Indexing and Abstracting**

- Mathematical Reviews
- MathSciNet
- Zentralblatt MATH (zbMath)



# International Journal of Mathematical Modelling and Numerical Optimisation

 This journal also publishes Open Access articles

**Editor in Chief**

Dr. Xin-She Yang

**ISSN online**

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**ISSN print**

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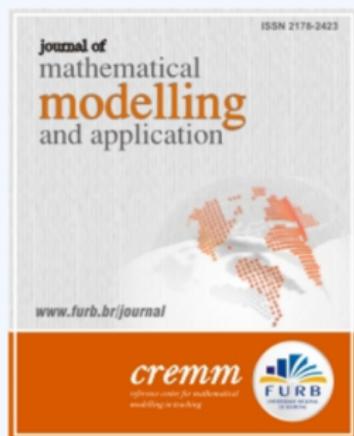
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# Journal of Mathematical Modelling and Application



## Indexer

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## List of issues

- [Volume 22 2017](#)
- [Volume 21 2016](#)

# Journal of Mathematical Modelling and Algorithms in Operations Research

ISSN: 2214-2487 (Print) 2214-2495 (Online)

## Description

Springer has made the difficult decision to cease publication of the Journal of Mathematical Modelling and Algorithms in Operations Research as of December 2015. Issue 14:4 will be the concluding issue for this journal.

Current submitted articles will be reviewed in the usual manner and those accepted will be published in an issue in 2015. All accepted articles currently published Online First will be published in the remaini ... [show all](#)

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## Latest Articles

Retraction Note

[Retraction Note to: A Multi-agent Based Self-adaptive Genetic Algorithm for the Long-term Car Pooling Problem](#)

Yuhan Guo, Gilles Goncalves, Tienté Hsu (December 2015)

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## Stay up to Date

Article abstracts by RSS

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## Course Description

- The course is designed for students who need to acquire the knowledge and skills of mathematical modeling at a high standard.
- The course emphasizes more the fundamental principle and thinking of mathematical modeling and computational methods. Thus, in the discussion of applications, generality instead of particular usage will be the focus.
- You are expected to have a good understanding of mathematical modeling.
- You should expect a high level of abstraction in mathematics and a rather fast pace of the lectures.

- You will acquire practical techniques during tutorial & experimental classes. In addition, students should consolidate the concepts by reading the textbook and working out exercises on their own. Besides attending lectures and tutorials, students are expected to spend at least 4 hours per week on this course plus 2-hour tutorial by TAs.
- The course will follow roughly the contents of the textbooks; with some rearrangement in the sequence of the topics.
- Learning in this course is not restricted by syllabus. You are encouraged to explore more advanced books by yourselves.
- The course content is not constrained by the lectures.

# Teaching info

Department Math, SUSTech  
MA206 Mathematical Modeling  
Instructor: Dr. Jingzhi Li  
E-mail: li.jz@sustech.edu.cn  
Office: Rm. 609, College of Science

QQ group: 1025801571  
TA: Mr. Zijun Jia  
E-mail: 12432020@mail.sustech.edu.cn  
Office: Rm. M5001, College of Science  
TA: Ms. XinShan Lai  
E-mail: 12432021@mail.sustech.edu.cn  
Office: Rm. M5001, College of Science

## Course Information

Besides general information given out by the university and registration section, particular ones about this course will usually be announced in lectures, course webpage, or sent to your campus wide email account. We do not send email to other accounts, so please set up your own email forwarding.

Set up a QQ discussion group administered by TAs.

Course GitHub link:

<https://github.com/jzlicuhk/MA206-MathModeling>

# Textbook and References

- **Basic Textbooks**

- A first course in Mathematical Modeling, (5th ed.) Frank R. Giordano, et al., Cengage Learning, 2014

- **References of similar level but different coverage**

- 数学建模姜启源等, 2018 (第五版), 高等教育出版社
- Mathematical Modeling, (4 ed.) Mark M. Meerschaert, Academic Press, 2013

# Grading policy

Attendance	Homework	Quiz	Project	Mid-term	Final
10%	10%	20%	30%	15%	15%

# Outline

A tentative schedule is given below for your reference.

- Introduction
- Writing skills\*
- Programming skills
- Modeling Change
- Modeling proportionality and Geometric Similarity
- Model Fitting
- Data-driven modeling
- Simulation Modeling

- Discrete Probabilistic Modeling
- Discrete Optimization Modeling
- Dimensional Analysis
- Modeling with Ordinary Differential Equations
- Optimization of Continuous Modeling
- Modeling with Graph Theory\*\*
- Modeling with Decision Theory\*\*
- Game Theory\*\*

## Preview of next lecture

### Writing skills & open source

- LaTeX
- Markdown
- GitHub

# Top prizes (彩蛋) in this course



2014

# Mathematical Contest In Modeling

## Certificate of Achievement

Be It Known That The Team Of

Rongpeng Li  
Wei Guo  
Lin Zhang

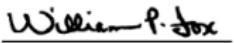
With Faculty Advisor

Jingzhi Li

of

South University of Science and Technology of China

Was Designated As  
Meritorious Winner



William P. Fox, Contest Director



  
Maynard Thompson, Head Judge



2022

# Mathematical Contest In Modeling®

## Certificate of Achievement

Be It Known That The Team Of

Wang Haoyu  
Chen Cheng  
Zhu Xiaoqi

With Faculty Advisor  
LI Jingzhi

Or

Southern University of Science and Technology

Was Designated As  
Finalist



Solomon Garfunkel, Executive Director

Administered by  
  
With support from



Steven B. Horton, Contest Director



## 最后，来点人文的

教育就是当一个人把在学校所学全部忘光之后剩下的东西。

Education is what remains after one has forgotten  
everything one has learned in school.

——爱因斯坦

若要优美的嘴唇，要讲亲切的话；若要可爱的眼睛，要看  
到别人的好处；若要苗条的身材，把你的食物分给饥饿的  
人；若要美丽的头发，让小孩子一天抚摸一次你的头发；  
若要优雅的姿势，走路时要记住行人不止你一个。

——赫本