Mathematical Modeling

M1200
Spring 2019

Yi Li, Ph. Inquiry (1+1 d.o.)
http://www.math.sustech.edu.cn/pages/show/1010/yqli

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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, but a course on modeling using ideas from basic and computational aspects in mathematics modeling.
- It is taught by an applied mathematician instead of a pure one.
- There is a serious evidence of a large math and CS research community emerging in modeling.
- Some of the materials covered in the MCM has phrase be prepared for a sequence of courses.
- My understanding is biased toward MCMs in China and the US.

About me

- Jingzhi Li, Ph.D., Associate 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

About me: Teaching

- 1+1 teaching Math. Modeling, Appl. Math, Finan. Math at SUSTech
- Graduate level
  - FTSE Numerical PDE.
- Undergraduate level:
  - Calculus, ODE, Math Modeling, Computational Finance, Numerical Analysis

About me: Research

- Inverse Problems in Math. PDEs:
  - 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.

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 non-physical systems such as the social sciences (such as economics, psychology, sociology, political science).

Modeling vs. Modeling

- Whether you're modeling or modeling, you're doing the same thing. The only difference is the spelling. One one with the model is predicted or modeled, the other with the model is predicted or modeled.

Interdisciplinary subject

A glimpse of books on MM

Research Journals

Research Journals

Research Journals

Research Journals

Research Journals

Research Journals

Course Description

- This course is designed to introduce students to some basic knowledge and skills of applied mathematics at a high school level.
- The course emphasizes more the fundamental principle and thinking of mathematical modeling and computation than the details of the mathematical theory and computational algorithms. Students are expected to understand the ideas behind the mathematical formulation of real-world problems.
- You should expect a high level of abstraction in mathematics, and a rather low level of rigorous proofs.
- Students are expected to have some basic knowledge in mathematics and be familiar with some basic computer skills. Knowledge in mathematics and computer skills will be reviewed when needed. Knowledge in linear algebra, lectures and tutorials, students are expected to spend at least 3 hours per week on the course outside the classroom.
- The course will follow roughly the contents of the textbook, with some additional materials from other sources.
- Learning in this course is not graded by syllabus. You are encouraged to discuss with classmates and ask questions.
- This course contains a set coursework by the lecturer.

Teaching info

Lecturer:	Prof. Dr. Jingzhi Li, jingzhi@gmail.com
Office:	Department of Mathematics, Room 1088 S
Time and Venue:	Lecture: Tue. 14:30 - 16:20 weeks, Room 1088 S Tutorial: Tue. 16:30 - 17:20 weeks, Room 1088 S
Tutor:	Mr. Yi Zhang, zhangyi@mail.sustc.edu.cn
Office Hours:	Tue. 17:20 - 18:20
Grading:	Mr. Yi Zhang, Mr. Kaiwen Zhang, Mr. Jiaqi Zhang
	10% HW 10% Quiz 20% Project 30% Mid-term 15% Final 15% Attendance

Course Information

Besides general information given on the syllabus, the course information will be posted on the course website, and will be supplemented by lecture notes, webpage, or tutor's notes (together with sample materials). We will use piazza and email to share information, as well as discussions in class.

Sign up for a piazza account at piazza.com/sustech/spring2019/m1200

Course web site:

http://www.math.sustc.edu.cn/teaching/M1200/

Piazza:

https://piazza.com/sustech/spring2019/m1200/home

Textbook and References

- **Basic Textbooks**
  - **A first course in Mathematical Modeling**, F. R. Giordano, M. D. Weir, W. P. Fox, 5th edition.
- **References of similar level but different coverage**
  - **数学建模** 赵静 主编, 高等教育出版社, 第四版.
  - **Mathematical Modeling**, 4th ed, Frank R. Giordano, Academic Press, 2011.

Grading policy

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

Outline

A tentative schedule is given on the next page.

- **Introduction**
- **Modeling**
- **Scaling**
- **Modeling proportionality and Geometric Similarity**
- **Mixing Problems**
- **Modeling Population**
- **Dimensional Analysis**
- **Matrix Models, Modeling Networks**
- **Discrete Optimization Modeling**
- **Modeling with Graphs**
- **Modeling with Ordinary Differential Equations**
- **Modeling with Partial Differential Equations**
- **Modeling with Graph Theory?**
- **Modeling with Game Theory?**
- **Game Theory?**

Homework 1

- *Pick one element from current and next week's lecture notes, or from your life.*
- *Write a short note (typo / error in the lecture notes/ or an example) or a question to me, from the personal **Applied Mathematical Modeling**.* 必修
- *Draft a crude plan for this course and show me your enthusiasm on coursing.* 必修
- *Contribute a Wiki article to **SUSTech-MMW** to share with peers using MediaWiki.* 选修

Due: 14:00 Tuesday in the lecture week

Preview of next lecture

- Writing skills & open source
  - LaTeX
    - https://blogs.yahoo.co.jp/2018/10/LaTeX_overview-10-1.html
  - Overleaf
  - MediaWiki
  - GitHub

最后，来点人文的

南怀瑾先生一日在台湾对学生说他在写《论语别裁》的时候，
Education is about concern after your has forgotten everything you has learned in school.

—NHJ

思想的自由解放，要必须经过这一段思想的混乱期，要有怀疑，要有反抗，要有冲突，要有矛盾，并经过最后的分析取舍，才能成熟。这一思想的混乱期，正是一个思想上的一次革命。
思想的解放期，这是两千年以来的大革命。

—NHJ