

Math 486 – Mathematical Modeling I

Course Description from Bulletin: The primary goal of this course is to provide students the power of using the principles and methods of mathematical modeling for studies of complex systems in science and engineering. The students will be introduced to the basic notions of the level of abstractions, and on how to work on real problems at different levels. The emphasis throughout is on the synergy between the rigorous mathematical approaches, accurate choice of scientific approximation, engineering estimates, and data analysis. A broad range of physical phenomena, engineering applications as well as biological systems will be considered. The use of methods of applied analysis, theoretical physics, probability and statistics will be described. Credit may not be granted for both MATH 486 and MATH 522. (3-0-3)

Enrollment: Elective for AM and other majors.

Textbook(s): Murray S. Klamkin, *Mathematical Modelling: Classroom Notes in Applied Mathematics*

Other required material: None

Prerequisites: MATH 461 and MATH 475 (or equivalents)

Objectives:

1. Students will be provided with the power of using the principles and methods of mathematical modeling for studies of complex systems in science and engineering.
2. Students will learn how to estimate "real" problems, to choose the proper approximation and the parameter set.
3. Students will learn how to describe the system properties with necessary level of mathematical rigor.
4. Students will learn how to apply various methods for modeling real problems in science and engineering, such as regular perturbations, asymptotic expansions, singularities, similarity approach, predictive capabilities of numerical methods.
5. Students will study how to compare the modeling results to observations and how to perform data analysis.

Lecture schedule: 3 50 minute (or 2 75 minute) lectures per week

Course Outline:

	Hours
1. System estimates and data analysis	4
2. Conservation laws, basic ODEs, PDEs and SDEs	3
3. Perturbative methods	4
4. Integral methods	3
5. Symmetry and group theory	2
6. Singularities	2
7. Nonlinear dynamics	6
8. Chaos	2
9. Self-similarity and turbulence	3

10. Statistical properties of physical systems	5
11. Modeling of biological systems	4
12. How to compare with observations	4

Assessment:	Homework	10-30%
	Computer Programs/Projects	10-20%
	Exams	20-50%
	Final Exam	30-50%

Syllabus prepared by: Snejana Abarji and Xiaofan Li

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