MA 422: Mathematical Modeling

Instructor: Lia Vas

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Office Hours: Monday 2-4, Friday 2-4 (no appointment necessary). Feel free to make an appointment if you cannot come to my regular office hours.

Text: No textbook is required. Handouts with new material and practice problems will be distributed for each teaching unit. Some textbooks used for the class preparation include:

- **D. Edwards and M. Hamson**, *Guide to Mathematical Modeling*, Published by CRC Press, 1990.
- **Giordano, Weir, and Fox,** *First Course in Mathematical Modeling*, Thomson Brooks/Cole, 2003.

Technology: Matlab will be used extensively and spreadsheets (Excel or equivalent) occasionally.

Topics covered:

1. Basic ideas and techniques of mathematical modeling: Modeling methodology. Modeling skills. Model testing.
2. Programing in Matlab. M-files.
3. Modeling with differential equations. Continuous dynamical systems.
4. Modeling with difference equations. Discrete dynamical systems.
5. Dimensional analysis.
6. Empirical (experimental) models. Effectiveness and validity.
7. Interpolation and model fitting.
8. Simulation modeling. Monte Carlo simulations.
9. Discrete and continuous optimization modeling.
10. Modeling with systems of difference equations. Basic idea of Markov chains.
11. Modeling with systems of differential equations. Steady states and stability.
12. Report writing and result presentation.

Grading:

Assignment 1	25%
Assignment 2	25%
Assignment 3	25%
Student Project	25%
TOTAL	**100%**

Grades are computed according to the following system:

grade	A+	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F
number grade	97 to 100	93 to 96	90 to 92	87 to 89	83 to 86	80 to 82	77 to 79	73 to 76	70 to 72	67 to 69	63 to 66	60 to 62	0 to 59

Course Requirements:

1. Prerequisites: MA221 or the permission of instructor.

2. **Attendance:** Since the course is mostly based on material covered in class handouts, it is absolutely imperative that students attend all classes. Students are responsible for all material covered in class, even if attendance is not checked or assignments collected.

3. **Assignments and projects:** There will be **3 assignments** and one **student project**. Assignments turned in after their due date will receive an automatic reduction in grade. No assignment grade will be dropped. See my website for instructions on presentations and presentation topics.

4. **More on Mathematical Modeling:**

- Mathematical models are used widely in natural, health and social sciences. The course will cover a variety of topics related to mathematical modeling and modeling techniques: discrete and continuous models, dynamical systems, stability of solutions, steady states.
- Algebra and calculus techniques that students have encounter in previous courses will be used for successful mathematical modeling of more complex problems. Because of this, the course can be considered a continuation of earlier mathematics courses and the next step in building students' problem solving skills.
- The course provides the students interested in continuing their education at a graduate level with mathematical techniques that certain graduate programs use.
- The course emphasizes research ideas, not just mastering various techniques or methods. These ideas are often used in various fields and will be a useful concept for students to acquire.

5. **Course Objectives.** By passing the course elements, student will be able to:

- identify a problem and choose an appropriate mathematical model,
- create a model that adequately describes the problem, using the appropriate technology if necessary,
- test the validity of the model,
- solve the problem using the appropriate technology if necessary,
- present the results orally, on computer and in a form of a written report.

6. **Learning outcomes:**

- Students will acquire knowledge of various mathematical concepts and modeling techniques required for successful application of mathematics.
- Students will be able to model data using the language and techniques of mathematics.
- Students will be able to understand and solve multidisciplinary application problems using mathematical models.
- Students will demonstrate a proficiency in using mathematical software.
- Students will know how to use appropriate technology to solve problems involving mathematical models.
- Students will demonstrate ability to cover a topic independently and present their results in an oral presentation as well as in a written report.

7. **Academic integrity:** Academic integrity is at the center of the educational experience at USciences. Students are therefore expected to uphold the highest standards of academic integrity and not engage in or tolerate academic dishonesty. Academic dishonesty includes, but is not limited to, fabrication, cheating or plagiarism. Any violation of academic integrity will be investigated and, where warranted, the student will receive appropriate sanctions through the University's Student Conduct Process. Please familiarize yourself with the current USciences Student Handbook. Adherence to the Student Conduct Policy and Academic Integrity Policy will help to ensure that your learning and living experiences are founded on integrity.

8. **Americans with Disabilities Act (ADA) Compliance Statement:** USciences supports the educational endeavors of all students, including students with disabilities. ADA defines a disability as a mental or physical impairment that substantially limits one or more major life activities. If you believe that you have a disability that may impact your ability to fulfill your course or degree requirements, and you would like more information on applying for an accommodation under ADA, please contact the Administrator of Student Accommodations at 215-596-8758.