Why Teach Mathematical Modeling?
For most people, the value of mathematics lies in applications, and modeling is one of the most useful applications of mathematics. One may model using mathematical equations, spreadsheets, computer simulations, or physical replicas. Not all forms of modeling are applicable to all problems, but each validated model gives insight into how the system under study works. Though we will look briefly at curve fitting and the use of spreadsheets, our main focus will be on System Dynamics Modeling. System Dynamics is the quantitative study of the actual causal structures and typical behaviors (causes, effects, and feedback loops) underlying system actions. The underlying mathematics is difference equations and ordinary differential equations (but you don’t need to know that to get started).

Instructional Personnel and Contact Information:

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Class Meetings
Class meetings will be held Monday/Wednesday, 5:30 – 6:45 PM in HHB 221, the Mathematics Computational Lab. Additional assisted lab time will be held Monday/Wednesday, 4:30 – 5:30 PM, in HHB 221. New material will be presented in class meetings. Assignments can be found on Blackboard Learn and may be printed before coming to class. Students will be following along using the computer software during much of the class meeting. The additional reserved hours of the computer lab are available for working on assignments and projects; during this time your teaching assistant will be present to answer questions and to provide assistance. You may also use the lab during other open hours (when a class is not present). Weekly open lab hours will be posted outside the lab. (Additional lab hours without assistance are in HHB 202. Several machines on the right wall have Stella installed.)

Software
We will use Microsoft EXCEL and High Performance Systems STELLA. If you prefer to work at home, student versions are available (bookstore for EXCEL and online at www.iseesystems.com for STELLA).

Computer Lab
The only computer labs that have STELLA installed are HHB 221 and HHB 202. You should always bring a thumb drive to the lab in order to save your work (frequently). Information left on the lab computers may be erased overnight (or whenever the computer is used by someone other than you).

Material to be covered
We will cover the following topics, using the computer software indicated.
1. Elements of data analysis, principally curve fitting, using EXCEL.
2. Recurrence Relations and Difference Equations, using EXCEL.
3. Introduction to System Dynamics, using STELLA, including
   a. Simple population models.
   b. Generic processes.
4. Introduction to Cellular Automata, using EXCEL
   a. Simple Averaging Automaton and the Morteville Story
5. Applications of System Dynamics, using STELLA, including
   a. Advanced population models, including overshoot and collapse.
   b. Epidemiological models, including variations on the SIR algorithm – an in-class small group activity.
   c. Drug assimilation (pharmacokinetic) models.
6. System Dynamics Stories (guided projects), using STELLA.

There is no formal textbook for the course, but there will be many assignments and instructions to be printed before coming to class. It is recommended that you secure your own copies of the software, if you have a computer at home. The mathematics behind the models will be discussed, assuming knowledge of algebra and functions (including linear functions, polynomials, rational functions, and exponential functions), differential calculus (limits, derivatives as rates of change, and linear approximation), and the definition and interpretation of the integral.
Assignments
There will be one or two assignments made every week. These will almost always involve computer work and written work. Written work must be neat and in complete sentences, as learning to communicate mathematics (and science) effectively is one of the aims of the course. Written mathematical work must show all steps. Computer printouts should be limited to those expressly requested or clearly needed. Producing piles of paper is not the goal.

The first few assignments will have two due dates: assignments turned in by the first due date will be marked and returned by the next meeting. They may be corrected and turned in again by the second due date, at which point an improved grade may be earned. Of course, you can wait until the second due date to turn in the assignment for the first time, but why deprive yourself of the opportunity to earn a better grade? Assignments turned in after the second due date will be severely downgraded, if graded at all. After the first few assignments, double-grading will cease and assignments will be graded only once.

You may discuss assignments with other students in the class, as well as with the instructional personnel, and you may work together with other students on the computer. If two (no more!) students work on an assignment together, you may turn in a single “partnership” assignment with two names. However, you are responsible for learning the material, and you will be expected to perform on your own, particularly on tests and the major project, described below.

Midterm Tests
There will be two midterm tests, at about 5 week intervals, focused on determining whether or not you have learned independently to use the tools and to understand the basic building blocks relevant to the kinds of models we are constructing. The midterm tests will be given in the computer lab. Even if you work with colleagues on assignments, it is vital that you learn to “drive” the computer yourself. You will have NO partner on the tests. The midterm tests will also include questions designed to determine if you understand the mathematics and logic behind the computer models.

System Dynamics Stories and Projects
About midway through the course you will be provided with a list of several “System Dynamics Stories,” scenarios describing realistic situations to be modeled. Each story provides all the data required for the model. The model will be developed in stages, called “Problems,” with testing and validation of the model at each stage. This is intended to be independent work. You may discuss your project with other students, but you will still be expected to produce a clearly independently constructed model and written report. You may NOT work jointly. (This is a fine line – be professional.) You will turn in answers to the Problems and a copy of your working model at least three weeks before the project due date (to be announced), for a preliminary evaluation. We will discuss your model with you promptly. Subsequently, you will revise it, if needed, and write a 5-10 page technical paper (plus Appendices) describing your model, following a Technical Paper Template we will provide. We will also give you a copy of the Scoring Guides we will use to grade your model and paper, and a rating of the difficulty of each Story, which will be taken into account in grading your model and paper.

Grading
Students registered for MA 361: the final grade for the course will be based 40% on assignments, 15% on each midterm test, and 30% on a System Dynamics Project (model plus report), modeling one of the System Dynamics Stories provided.

Students registered for MA 519: the final grade for the course will be based 30% on assignments, 15% on each midterm test, 10% on one System Dynamics Project, model only, and 30% on a second, complete (model plus report), Systems Dynamics Project.

Withdrawal
The usual rules apply for withdrawing from the course. Note that undergraduate and graduate students have different withdrawal deadline dates.

Disability Support Services
If you are registered with Disability Support Services, please make an appointment with me as soon as possible to discuss accommodations that may be necessary. If you have a disability but have not contacted Disability Support Services, please call 934-4205 or visit DSS at 516 Hill University Center. Students who may need course accommodations are welcome to make an appointment to see me during office hours. Students with disabilities must be registered with Disability Support Services, HUC 516 or 934-4205, and provide an accommodation request letter before receiving academic adjustments.