E553 & E710 Creation and Solution of Environmental Models
(E553 may be listed as E555, but it is this same course)
Spring 2005 -- David Parkhurst
Tuesday, Thursday, 11:15–12:30 (room TBA)

Mathematical models take many forms depending on their purposes. In basic science, a model acts as a framework for tying together groups of hypotheses relevant for explaining some phenomenon or set of phenomena, and to check out the self-consistency and the interactions among those hypotheses. In applications they are also used to predict potential results of various management options, and sometimes, to choose an optimal (or at least an adequate) action. Besides, writing models is fun.

Writing effective models requires:
- Knowledge of the subject matter under study
- Knowledge of mathematics
- Creativity
- Willingness to test your own models stringently, allowing them to be thrown away or changed if they don't meet their purposes
- Tools for solving complex models that are not solvable in the head, or with pencil and paper

Some of these parts can be taught, while others (e.g. creativity, or willingness to put your models at risk) are not so easy to teach—however, we can try.

This course will be woven together from several threads:
- Examples of various model **structures**, with some emphasis on systems of differential equations. We will also consider difference equations, optimization models, and others, including both deterministic and stochastic aspects.
- Mathematical properties of these structures, including both dynamic and equilibrium aspects.
- Matlab, software that allows both analytical and numerical exploration of models.
- Building a catalog of mathematical functions, so we can use them as input to models, or understand them when they arise as model output.
- Principles of transport and exchange of energy and mass in the environment.
- The concepts of positive and negative feedback.
- If there is interest, models involving chaos.

Course Activities and Grading

You will be learning these various concepts from lectures, textbooks, assigned papers, small-group discussions, homework, a group project, and an individual project.

For the group projects, I will divide you into groups of about three or four. Each group will act as a team to model a situation yet to be determined. Your job will be to create, program, and run a model simulating the situation modelled. Each group will present its project orally to the class, and in writing to me.

For the individual project, you will choose your own situation to model. Your model should have a defined purpose and audience. You will create, program, and run it, then write a report describing the results in relation to the stated purpose.

The various components of the course will be graded with the following weights:

Exam I	80
Exam II	80
Group Project	100
Individual Project	120
Homework	up to 100 (to be determined)

Texts and Reading

The basic text for the course is

Modeling Biological Systems, Principles and Applications. J.W. Haefner. 1996. Chapman & Hall, NY.

This book is costly (c. $160) so a copy will be available on reserve, for those who choose not to purchase it. If you do want a copy, you may have to ask the bookstore to order it for you—they don't buy many copies of books that the instructor does not list as required. You will also likely want a book on Matlab. Two good possibilities are:

Higham, D. J., and N. J. Higham. 2000. Matlab Guide. Society of Industrial and Applied Mathematics (SIAM), Philadelphia. This is available in both hardback and paper-bound editions. The latter costs about $30, I think.

Hanselman, D., and B. Littlefield. 2001. Mastering Matlab 6. Prentice Hall, Upper Saddle River, NJ. This is a more comprehensive reference, but it costs about $64.

Matlab tutorials are available on the web, such as http://www.math.utah.edu/lab/ms/matlab/matlab.html.

For further information, please contact the instructor:
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