Mathematical Ecology II – Math/EEB582 - Syllabus Spring 2016
Math 582 Section#1 - EEB 581 Section#1

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Home Page: http://www.NIMBioS.org /~gross/math582.html
Meeting time: 1:25-2:15
MWF Place: Ayres 122
Final "exam" meeting: May 4 12:30-2:30

Objectives: This is the second course in a sequence. The overall goal of this course sequence is to provide an overview of mathematical approaches in ecology. The emphasis is on developing participants appreciation for the variety of approaches an applied mathematician may take in addressing real-world problems. There is a particular focus on the development of mathematical models to elucidate general patterns arising in natural systems. Although the emphasis is on ecological patterns, the approaches we will discuss are readily applicable across the sciences. By the end of the sequence, participants should be capable of reading current research and be prepared to pass a preliminary examination in the field. The course presumes mathematical maturity at the level of advanced calculus with prior exposure to basic differential equations, linear algebra, and probability. Although prior experience with Math581 is expected in general, those who have not taken this first part of the sequence may be able to benefit from just participating in Math582, and should discuss their objectives with the instructor.

Textbook: Elements of Mathematical Ecology by Mark Kot. Cambridge University Press, 2001. As was done in Math581, we will follow this text fairly closely. The text will be supplemented by materials from several texts on the reference list, as well as journal papers assigned in class. Topics to be covered are given below, though these may be modified to a certain extent by the interests of class participants.

Format: The course will be taught in mixed lecture/discussion format, with readings from the text or other materials discussed as appropriate and as needed the instructor will lecture on material. Class participants will be expected to attend some special colloquia related to the topics of the course as they are held during the semester. Students who audit must attend lectures, do the assigned readings and participate in discussions.

Class Grading: I will assign problems related to the course material as homework. You may work on such problems with others from the course, but you must independently write up your results, and make it clear with whom you have collaborated on each homework set. In addition to assignments from the text, which should help you prepare for a preliminary exam on the topic areas of the course that some of you intend to take, I expect each participant to (i) participate in a group project and (ii) develop an individual project that relates to the course sequence topics mathematically and is of use in preparing you for dissertation/thesis completion. Course grading will be based upon: assignments (40% of grade), group project (20%), individual project (40%).

Group Project: The objective of this is to provide an opportunity for all participants to collaborate on a project that involves data in some manner. Since the majority of the course topics are focused on theory development in ecology and the mathematical analysis of models arising from this theory, the project offers the opportunity to relate the theory to data. This will likely involve computational methods, and thus the participants are expected to learn about these methods as developed for the project.

Individual Project: the objective of this is to encourage participants to delve in some detail into a particular problem of interest to them, and to provide an opportunity to practice technical report writing. If appropriate, this project could be heavily computational rather than focused on mathematical analysis. It is possible that this project could be used, with further effort, as a basis for either a Masters thesis or a project for the non-thesis Masters option in the Math Department, or it may assist the participant in preparing a dissertation. Participants will be expected to choose a project by mid-semester, and hand in to the instructor a one page description of what they intend to pursue. The instructor will provide suggested project topics if a participant so desires. The final project report should be produced as a technical report, in standard scientific format, and should be in the range of 10-20 typed pages. The report should include an abstract, an introduction describing background material, a methods section describing the tools applied, a results section, a conclusions section that particularly includes future enhancements that are possible, and a bibliography. Participants may make use of any of a number of tools available on campus in carrying out this project, notably software tools such as Maple, Mathematica, R and Matlab, as well as specialized ecological modeling tools such as RAMAS and NetLogo. Alternatively, participants may write their own codes in any computer language of their choosing. The report is expected to include any codes or programming notebooks developed as an appendix. The project is due on the date of the final exam period for the class, during which period each participant is expected to give a brief 10-15 minute oral presentation on their project, including appropriate powerpoint or pdf slides.

Topic Coverage for the semester:

- Interacting population models
  - Competition models
  - Mutualism
- Population harvesting and optimal control - introduction to bioeconomics and optimization methods
- Spatially-structured population models
  - Patch and metapopulation models
  - Reaction-diffusion models
    - Linear models and spatial steady-states
    - Nonlinear models and spatial steady-states
    - Models of spread
- Age-structured population models
  - Lotka integral equation and renewal equation
  - Leslie matrices and extensions

McKendrick- von Foerster equation
Simple non-linear models
Two sex models

What we will likely not cover: There are many topics within mathematical ecology that are not included in this course sequence, some of which are listed below. Any of these could serve as a basis for the course projects. Note that some of these topics are included in either special seminar courses such as Math589, or in Math/EEB 681-2. If there is particular interest on the part of course participants in some of these, I can possibly rearrange the schedule to briefly include them. Please inform the instructor if you have a particular interest in one of the below.

Biophysical ecology and physiological ecology models
Stochastic community models
Food web models
Spatial community models
Network models for populations and communities
Cellular automata approaches
Individual-based models
Integro-differential equation models (general delay models)
Integro-difference equation models
Fluctuating environment models
Spatial branching and L-systems
Epidemic models
Neural nets, genetic algorithms, A-life models

Key Professional Journals in the Field:

American Naturalist
Bulletin of Mathematical Biology
Journal of Mathematical Biology
Journal of Theoretical Biology
Mathematical Biosciences
Mathematical Biosciences and Engineering
Theoretical Ecology
Theoretical Population Biology