Mathematical Ecology – Math/EEB581 - Syllabus Fall 2016
Math 581 Section#1 - EEB 581 Section#1

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Home Page: http://www.NIMBioS.org /~gross/math581.html
Meeting time: 1:25-2:15
MWF Place: Ayres 112
Final “exam” meeting: December 6, 12:30-2:30PM

Objectives: The goal of this course sequence is to provide an overview of mathematical approaches in ecology. The emphasis is on developing participant’s 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 two-course sequence, students 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.

Textbook: *Elements of Mathematical Ecology* by Mark Kot. Cambridge University Press, 2001. 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. Several readings will come from the *Encyclopedia of Theoretical Ecology* (A. Hastings and L. J. Gross, eds.) which is available as an e-book from the UTK library.

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. Students are encouraged to attend Math 589/EEB504 to obtain additional perspectives on the course topics.

Class Grading: I will regularly 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. I expect to give one test at the end of the semester, to aid you in preparing for the preliminary exam. This will likely be a take-home exam. There will also be one computer-based project due at the end of the semester. Course grading will be based upon: test (25% of grade), homework (50%), project (25%).

Individual Project: There will be a computer-based project that will be due at the end of the semester. The objective here is to ensure that all participants are familiar with some standard methods to numerically analyze a more complex problem in math ecology that analytical methods are not able to address. It is also 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. 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. 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 5-10 minute oral presentation on their project, including appropriate Powerpoint or pdf slides.

Topic Coverage for the semester:

Single-species population models
- Continuous-time ODE models
- Continuous-time stochastic models - birth and death processes
- Discrete-time deterministic models - difference equations
- Discrete-time stochastic models - branching processes

Interacting population models
- Predator-prey
- Chemostat models
- Competition models
- Mutualism

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
Letters in Biomathematics
Mathematical Biosciences
Mathematical Biosciences and Engineering
Theoretical Ecology
Theoretical Population Biology

Note that many SIAM journals include mathematical ecology papers

Campus Syllabus:
The formal Campus Syllabus is an addendum to this syllabus – it is posted on the course webpage and includes information about disability services, civility, and wellness. If you use a name and/or pronouns other than what is in the course roll, please email me with the name and/or pronouns that you would like me to use and I will be glad to accommodate this request.