BIOL 5333-001 Biological Modeling

Fall 2011

Instructor(s): James P. Grover
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Office Hours: TuTh 3:00-5:00 PM, F 10-11 AM, or by appointment

Time and Place of Class Meetings: Life Science Building room B27, TuTh 5:30-6:50 PM

Description of Course Content: Representation of biological processes with linear and nonlinear differential and difference equations, using examples from physiology, population biology, and ecology. Topics include graphical analysis, simulation stochastic processes, chaos, and fractals.

Student Learning Outcomes: Students will become familiar with constructing and analyzing models to study ecological and evolutionary processes, including use of the MATLAB computational platform. Students will review and analyze classical and contemporary issues in theoretical biology. These objectives will be assessed through evaluations of course projects.

Requirements: This course assumes that students have taken at least one semester of calculus and have seen derivatives and some related matters. Students must have access to a computer capable of compiling and running MATLAB software. The classroom for the course has several such computers, as do some of the other campus computing facilities for students. Students should be familiar with basic computer tasks such as managing files and documents, word processing, spreadsheets and basic graphics. It will probably be helpful to have a flash drive with space for saving files related to the course.

Required Textbooks and Other Course Materials: Information and links for readings and assignments will be provided as needed.

- Computations for this course will be done with the MATLAB program
- Some supplementary materials may be useful. Two books will be on reserve at the Science and Engineering Library: Ecological Dynamics by Gurney and Nisbet, and Modeling Biological Systems by Haefner. These books provide somewhat different theoretical perspectives from the course material, and could be a source of inspiration for course projects. It may be helpful to have access to a reference manual on basics of the MATLAB software (there are many on the market). One possibility is Getting Started with MATLAB, by Rudra Pratap (Oxford University Press).

Descriptions of major assignments and examinations with due dates: Homework will be assigned periodically and will count for 1/2 of the course grade. It will be designed to exercise and reinforce skills and concepts covered during the course. Most homework will require writing and using computer programs. Due dates and reporting formats for homework assignments will be specified when the homework is assigned.

Each student will also complete two projects – a mini-project and a course project.

The mini-project will be assigned at the end of the second lecture topic in the course outline. It will involve applying the programming and mathematical techniques taught in that topic to do a theoretical study of the population dynamics of an organism of your choice. A written report will be required and guidance for this will be given when the mini-project is assigned. The due date will be specified at that time.

The longer course project should address a substantive question in theoretical biology using the skills and concepts covered in this course. The project must use computer analyses. The project report must summarize the model equation(s) used, describe how necessary parameters were estimated, present verbal and graphical summaries of mathematical analyses and computational results, and cover the theoretical context of the project, reviewing relevant published literature on the topic. Projects will be graded based on the following criteria: originality and difficulty of the topic; suitability of mathematical and computational analyses for the research questions; thoroughness of analyses; clarity and intellectual content of the text.
describing the research context; and thoroughness of the literature review. A good project report will have an introduction stating the research questions and briefly setting the theoretical context, a description of model equations and computational protocols, a presentation of detailed mathematical and computational results, and a discussion of the findings and an evaluation of the conclusions in light of previous literature.

All students must choose a project topic and report it to the instructor in writing by October 20, 2011. Suggestions for project topics will be made during the first several weeks of the course. However, I encourage students to pursue projects related to their own research interests. A rough draft / progress report on the course project will be due November 10, 2011. Guidance for this report will be given in class. Feedback on project progress will be given in class on November 15, 2011. The course project will be due on December 8, 2011.

There are no exams. Important dates to remember are:

- Course Project Topics Due: October 20, 2011
- Course Project Drafts Due: November 10, 2011
- Course Project Due: December 8, 2011
- Last Class: December 8, 2011

**Course Topics**

We will try to cover these topics during the semester. We will be flexible about timing and it is possible that not all of the later topics will be covered.

1. Basics of dynamic modeling
   - Interlude – tutorial on MATLAB

2. One-dimensional models
   - A. Immigration-emigration and flow-concentration models
   - B. Population growth (exponential and logistic equations)
   - C. Chemostat model
   - D. Discrete models, cycles and chaos
   - E. Simple random walk
   - F. Stochastic birth-death models
   - G. Logistic birth-death processes

3. Two-dimensional models
   - A. Two compartment flow concentration models
   - B. Oversimplified predator-prey model
   - C. Competition models
   - D. Better predator-prey models

4. Higher-dimensional models
   - A. General ideas
   - B. Matrix models for structured populations
   - C. Droop model
   - D. Multispecies competition models
   - E. Predation-competition models
   - F. The paradox of diversity
   - G. Food webs, complexity, stability, trophic cascades, etc.
   - H. Metapopulation and epidemiological models (SEIR)

5. Modeling variability in the world
   - A. Forced deterministic models
   - B. Stochastic epidemiological models
   - C. General approaches to spatial variation

**Grading Policy:**

- Periodic homework assignments: 50%
- Mini-Project: 15%
- Main Project: 35%
Examinations: There are no exams for this course; grades will be based on only on homework assignments and projects. There is no extra credit in this course.

Late work: It will probably be possible to tolerate late work in most instances, but you should discuss any problems in completing work with the instructor at the earliest possible opportunity. To avoid an incomplete grade, all course work must be turned in by the scheduled date of the final examination.

Tardiness: I intend to start classes on time. Arriving late disturbs other students already present and disrupts the learning process. Please be considerate and plan to be on time.

Cell phones: Please remember to turn off audible cell phones and pagers during class.

Incomplete grades: A grade of incomplete will only be assigned for students who are physically unable to complete the course due to serious illness or injury.

Make-up Exam Policy: There are no exams in this course.

Grade disputes: The instructor is willing to review the scoring of homework assignments and projects, but requests to do so must be made within two weeks of the date that graded work is distributed in class.

Drop policy: Withdrawal from the course must follow all pertinent University and Departmental regulations and deadline dates. Any student experiencing difficulties leading them to consider dropping the course should talk to the instructor to obtain their advice and help in avoiding any negative consequences. The last date to drop a class and receive a grade of W is November 4, 2011.

Students will not be automatically dropped for non-attendance. Repayment of certain types of financial aid administered through the University may be required as the result of dropping classes or withdrawing. Contact the Financial Aid Office for more information.

Other issues: Class participation is an important aspect of this course, so be considerate of other students and arrive on time. Turn off cell phones and pagers.

Attendance Policy: Students who habitually miss class tend to perform poorly. Attend class regularly to get the full benefits of your tuition payments.

Important University Policies:

Americans with Disabilities Act: The University of Texas at Arlington is on record as being committed to both the spirit and letter of all federal equal opportunity legislation, including the Americans with Disabilities Act (ADA). All instructors at UT Arlington are required by law to provide "reasonable accommodations" to students with disabilities, so as not to discriminate on the basis of that disability. Any student requiring an accommodation for this course must provide the instructor with official documentation in the form of a letter certified by the staff in the Office for Students with Disabilities, University Hall 102. Only those students who have officially documented a need for an accommodation will have their request honored. Information regarding diagnostic criteria and policies for obtaining disability-based academic accommodations can be found at www.uta.edu/disability or by calling the Office for Students with Disabilities at (817) 272-3364.

Academic Integrity: It is the philosophy of The University of Texas at Arlington that academic dishonesty is a completely unacceptable mode of conduct and will not be tolerated in any form. All persons involved in academic dishonesty will be disciplined in accordance with University regulations and procedures. Discipline may include suspension or expulsion from the University. According to the UT System Regents’ Rule 50101, §2.2, "Scholastic dishonesty includes but is not limited to cheating, plagiarism, collusion, the submission for credit of any work or materials that are attributable in whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student or the attempt to commit such acts."

Student Support Services Available: The University of Texas at Arlington provides a variety of resources and programs designed to help students develop academic skills, deal with personal situations, and better understand concepts and information related to their courses. These resources include tutoring, major-based learning centers, developmental education, advising and mentoring, personal counseling, and federally funded programs. For individualized referrals to resources for any reason, students may contact the Maverick Resource Hotline at 817-272-6107 or visit www.uta.edu/resources for more information.

Electronic Communication Policy: The University of Texas at Arlington has adopted the University “MavMail” address as the sole official means of communication with students. MavMail is used to remind
students of important deadlines, advertise events and activities, and permit the University to conduct official transactions exclusively by electronic means. For example, important information concerning registration, financial aid, payment of bills, and graduation are now sent to students through the MavMail system. All students are assigned a MavMail account. Students are responsible for checking their MavMail regularly. Information about activating and using MavMail is available at http://www.uta.edu/oit/email/. There is no additional charge to students for using this account, and it remains active even after they graduate from UT Arlington.

**Final Review Week:** A period of five class days prior to the first day of final examinations in the long sessions shall be designated as Final Review Week. The purpose of this week is to allow students sufficient time to prepare for final examinations. During this week, there shall be no scheduled activities such as required field trips or performances; and no instructor shall assign any themes, research problems or exercises of similar scope that have a completion date during or following this week unless specified in the class syllabus. During Final Review Week, an instructor shall not give any examinations constituting 10% or more of the final grade, except makeup tests and laboratory examinations. In addition, no instructor shall give any portion of the final examination during Final Review Week. Classes are held as scheduled during this week and lectures and presentations may be given.

**After Hours Safety Escort:** The Sam Mav Escort service provides a service to assist students, faculty, staff and campus visitors to reach their destinations after regular business hours. The hours of service are 7:00 p.m. to 1:00 a.m., Sunday through Saturday. 817-272-3381.