BIOL 5333-001: Biological Modeling
Fall 2014

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Time and Place of Class Meetings: Life Science 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, and chaos.

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.

Required Textbooks and Other Course Materials: 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. There is no textbook, but lecture notes and readings will be posted to Blackboard. Some other 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. My book, *Resource Competition*, will also be placed on reserve. 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: 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 longer course project.

The mini-project will be assigned at the end of the second lecture topic in the course outline, on one-dimensional models. It will involve applying the programming and mathematical techniques taught in that topic to do a theoretical study of the population dynamics of a species 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. As we work through the topic of one-dimensional models, you are encouraged to think about how the various models we review might be applied to a species you are interested in, and you are encouraged to raise questions about this during class or individually with the instructor.

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, and must be more complicated than the simple one-dimensional models presented in course topic two. There are many ways such complications may be constructed, and you are encouraged to think about your project as the course progresses. The best projects apply concepts and skills reviewed in the course to a biological situation of personal interest to you. It would be good to read ahead in the course materials provided and think about how what you read

applies to biological phenomena that interest you. Raising questions about possible projects during class or individually with the instructor is encouraged. Some suggestions about possible topics will also be provided.

A written project report will be required, and guidance will be issued as the course progresses. The project report must summarize the model equations 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 21, 2014. A rough draft / progress report on the course project will be due November 11, 2014. Feedback on project progress will be given in class on November 13, 2011. The course project will be due on December 2, 2014.

There are no exams. Important dates to remember are

Course Project Topics Due:	October 21, 2011
Course Project Drafts Due:	November 11, 2011
Course Project Due:	December 2, 2011
Last Class:	December 2, 2011

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 (December 9, 2014).

Attendance: At the University of Texas at Arlington, taking attendance is not required. Rather, each faculty member is free to develop his or her own methods of evaluating students' academic performance, which includes establishing course-specific policies on attendance. As the instructor of this course, I will not be taking attendance but will expect attendance at all classes unless there is a legitimate professional or university-related reason for absence. I expect students to schedule their family, work and other activities so as to permit regular attendance. I also expect students to arrive prepared for class by reading ahead in the materials provided in Blackboard, and I expect active participation and strongly encourage asking questions and holding discussions about course material. There will be no class on Thursday, September 11, 2014, and no class on Thursday, October 9, 2014.

Grading: One half of the course grade will be computed from scores homework assignments, thirty-five percent will be computed from the longer course project, and fifteen percent from the mini-project. All assignments and reports will be graded on a 100-point scale, and the course average will be computed with the weights indicated. Letter grades will be assigned on a 100-point scale with 10-point increments. Students are expected to keep track of their performance throughout the semester and seek guidance from available sources (including the instructor) if their performance drops below satisfactory levels; see "Student Support Services," below.

Expectations for Out-of-Class Study: Beyond the time required to attend each class meeting, students enrolled in this course should expect to spend at least an additional 9 hours per week of their own time in course-related activities, including reading required materials, completing assignments, preparing for exams, etc.

Grade Grievances: Any appeal of a grade in this course must follow the procedures and deadlines for grade-related grievances as published in the current University Catalog.

Drop Policy: Students may drop or swap (adding and dropping a class concurrently) classes through self-service in MyMav from the beginning of the registration period through the late registration period. After the late registration period, students must see their academic advisor to drop a class or withdraw. Undeclared students must see an advisor in the

University Advising Center. Drops can continue through a point two-thirds of the way through the term or session. It is the student's responsibility to officially withdraw if they do not plan to attend after registering. **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. For more information, contact the Office of Financial Aid and Scholarships (http://wweb.uta.edu/aao/fao/).

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.

Title IX: The University of Texas at Arlington is committed to upholding U.S. Federal Law "Title IX" such that no member of the UT Arlington community shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity. For more information, visit www.uta.edu/titleIX.

Academic Integrity: Students enrolled all UT Arlington courses are expected to adhere to the UT Arlington Honor Code:

> *I pledge, on my honor, to uphold UT Arlington's tradition of academic integrity, a tradition that values hard work and honest effort in the pursuit of academic excellence.*
>
> *I promise that I will submit only work that I personally create or contribute to group collaborations, and I will appropriately reference any work from other sources. I will follow the highest standards of integrity and uphold the spirit of the Honor Code.*

UT Arlington faculty members may employ the Honor Code as they see fit in their courses, including (but not limited to) having students acknowledge the honor code as part of an examination or requiring students to incorporate the honor code into any work submitted. Per UT System *Regents' Rule* 50101, §2.2, suspected violations of university's standards for academic integrity (including the Honor Code) will be referred to the Office of Student Conduct. Violators will be disciplined in accordance with University policy, which may result in the student's suspension or expulsion from the University.

Electronic Communication: UT Arlington has adopted MavMail as its official means to communicate with students about important deadlines and events, as well as to transact university-related business regarding financial aid, tuition, grades, graduation, etc. All students are assigned a MavMail account and are responsible for checking the inbox regularly. There is no additional charge to students for using this account, which remains active even after graduation. Information about activating and using MavMail is available at http://www.uta.edu/oit/cs/email/mavmail.php.

Student Feedback Survey: At the end of each term, students enrolled in classes categorized as "lecture," "seminar," or "laboratory" shall be directed to complete an online Student Feedback Survey (SFS). Instructions on how to access the SFS for this course will be sent directly to each student through MavMail approximately 10 days before the end of the term. Each student's feedback enters the SFS database anonymously and is aggregated with that of other students enrolled in the course. UT Arlington's effort to solicit, gather, tabulate, and publish student feedback is required by state law; students are strongly urged to participate. For more information, visit http://www.uta.edu/sfs.

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. During this week, classes are held as scheduled. In addition, instructors are not required to limit content to topics that have been previously covered; they may introduce new concepts as appropriate.

Emergency Exit Procedures: Should we experience an emergency event that requires us to vacate the building, students should exit the room and move toward the nearest exit, which is accessed through the stairway to the left when leaving the classroom. When exiting the building during an emergency, one should never take an elevator but should use the stairwells. Faculty members and instructional staff will assist students in selecting the safest route for evacuation and will make arrangements to assist individuals with disabilities.

Student Support Services: UT 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. Resources include tutoring, major-based learning centers, developmental education, advising and mentoring, personal counseling, and federally funded programs. For individualized referrals, students may visit the reception desk at University College (Ransom Hall), call the Maverick Resource Hotline at 817-272-6107, send a message to resources@uta.edu, or view the information at www.uta.edu/resources.

Writing Center. : The Writing Center, 411 Central Library, offers individual 40 minute sessions to review assignments, *Quick Hits* (5-10 minute quick answers to questions), and workshops on grammar and specific writing projects. Visit https://uta.mywconline.com/ to register and make appointments. For hours, information about the writing workshops we offer, scheduling a classroom visit, and descriptions of the services we offer undergraduates, graduate students, and faculty members, please visit our website at www.uta.edu/owl/.

Course Schedule

We will try to cover these topics during the semester. The dates for each topic are approximate and will be varied if needed to meet the educational objectives of the course. 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 (Aug. 21, 26)

Interlude – tutorial on MATLAB (Aug. 26, 28)

2. One-dimensional models (Aug. 28 – Oct. 2)
    - 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 (Oct. 2 – Nov. 6)
    - A. Two compartment flow concentration models
    - B. Oversimplified predator-prey model
    - C. Competition models
    - D. Better predator-prey models
4. Higher-dimensional models (Nov. 6 – 20)
    - 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 (Nov. 20 – Dec. 2)
    - A. Temporal variation and forced deterministic models
    - B. General approaches to spatial variation
    - C. Stochastic epidemiological models

Emergency Phone Numbers: In case of an on-campus emergency, call the UT Arlington Police Department at **817-272-3003** (non-campus phone), **2-3003** (campus phone). You may also dial 911.

Web Pages for Library Support:

Library Home Page	http://www.uta.edu/library
Subject Guides	http://libguides.uta.edu
Subject Librarians	http://www.uta.edu/library/help/subject-librarians.php
Database List	http://www.uta.edu/library/databases/index.php
Course Reserves	http://pulse.uta.edu/vwebv/enterCourseReserve.do
Library Tutorials	http://www.uta.edu/library/help/tutorials.php
Connecting from Off- Campus	http://libguides.uta.edu/offcampus
Ask A Librarian	http://ask.uta.edu