Math 460 – Mathematical Modeling
Spring 2014

Instructor: John Rhodes, j.rhodes@alaska.edu; 102 Chapman, 474-5445

Office Hours: M 9:00-10:00, W 2:00-3:00, F 10:00-11:00 and by appointment

Web page: `http://www.dms.uaf.edu/~jrhodes/M460.html`

Prerequisites: COMM 131 or 141; ENGL 111; ENGL 211 or 213; MATH 201; or permission of the instructor

Credit Hours: 3.0

Text: *Mathematical Models in Biology: An Introduction*, by Allman and Rhodes; A solution manual for all problems in the text will be made available to borrow for short periods, but it should not be taken out of Chapman.

Class Meetings: MWF 11:45-12:45 in 106 Chapman;

Exams: Midterms: Wed., Feb. 26; Wed., April 9;
Final: Fri., May 9, 10:15–12:15

Computer Lab: Outside of class, you will need to use the software package MATLAB for some homework problems and for longer projects. It should be available in the Bunnell 319 Student Access Lab, the Chapman 305 Math & Stat Lab (4 machines), and many other places on campus. (UAF has a site license, so you may request installation by OIT on any UAF-owned computer.) You will also need to download some MATLAB scripts, called m-files, which are available on the class web page.

Course overview and goals: 'Mathematical modeling' refers to the formulation and analysis of mathematical descriptions of any kind of phenomena. A few examples of models include Newton's law, $F = ma$, describing how forces cause motion; Mendelian genetics, which uses probability to describe inheritance; and the atmospheric computer models often in the news on climate change. These examples illustrate that essentially all quantitative areas of science rely heavily on mathematical modeling, but the nature of the models can vary widely.

While models appear as examples in many math classes, usually the focus is only on the mathematical structure of the model, or using the model to draw conclusions, but not on how it was formulated. This course will be different, in that its primary goal is to teach the formulation and interpretation of the model. Though you will learn new mathematical tools and techniques, these will be introduced not for their own interest, but for application to understanding something outside of mathematics. You will also gain experience in communicating the conclusions you draw from a mathematical model.

The modeling in this course will all occur in biological contexts. For some of you, that may match your interests exactly. If it does not, you will still be learning how to model in ways that will transfer to other fields. For teaching modeling, biological problems have several advantages: we all have some basic intuitions about what are biologically reasonable assumptions, few undergraduates have been exposed to much mathematical biology so everyone begins at about the same level, and biology is very diverse so many types of models are needed. Finally, mathematical biology is a rapidly growing area, and is widely expected to play a crucial role in both biological and mathematical research in the future.

Student learning outcomes: By the end of this course you should be able to formulate and explain basic models of a variety of biological phenomena. You should know standard techniques for analyzing these models, and be able to draw biological conclusions from them. These techniques include both computer simulation and mathematical calculations. You should also be experienced at communicating and justifying your models, analyses, and conclusions in written form to an intelligent audience of non-experts.

Mechanics of the course: My current plan is to cover much of Chapters 1–7 of the text. Main topics include 1) dynamic models in one and more variables, linear and non-linear, as applied to ecology and demography, 2) molecular evolution and phylogenetics, from the rapidly-developing area of bioinformatics, 3) genetics, and 4) epidemiological modeling.

Computers will be used extensively in the course, both during class sessions and for homework. We'll use the general purpose numerical software package MATLAB, together with some special MATLAB programs, called `m`-files, written to go with the text. MATLAB is available in computer labs on campus, but you will have to download the m-files from the course webpage.

Homework problems will usually be assigned daily, but only collected each Wednesday (due in class, but accepted until 5pm at my office or mailbox). Homework problems will be posted on the course web page as they are assigned.

I will not accept any late homework that has not been cleared ahead of time. *There will be no exceptions to this* other than for a genuine emergency (e.g., a death in the family, documented illness, etc.).

The entire homework assignment will be checked to be sure you have attempted everything. Selected problems will be graded more completely. Even though you may find you can't do every problem, you must make a reasonable attempt on them all.

Laboratory exercises and projects will be a major portion of both course instruction and grading. The projects will generally entail some mathematical work, some computer investigation, and some biological discussion. You will report on your work in written form, with clarity of presentation taken into account in grading.

Collaborative work with other students is acceptable and encouraged on all the homework, though you must turn in assignments individually.

Collaborative work on projects is also encouraged, but subject to the following rules:

1. You may perform all investigations, whether mathematical or computer, with **at most one other student**. You may discuss everything about the project, including all conclusions with this person. You must **identify your collaborator** in your written work.
2. You may **either** write a joint report for which you will each receive the same grade, **or** you may each write your own reports, for which you will receive individual grades.
3. I reserve the right to require particular students to write individual reports if I have reason to believe they are not pulling their weight in a collaboration.

Grading: Your performance will be evaluated based on two midterm exams at 15% each; routine homework 10%; projects 35%; class participation 5%; and final exam 20% . Course grades will be determined according to the following cutoffs:

$$A \geq 90\%, \quad B \geq 80\%, \quad C \geq 70\%, \quad D \geq 60\%.$$

Cutoff points may be moved downward if particular exams or projects turn out to be unexpectedly difficult. Note that you are not in competition with your peers – everyone in the class may get an A, or everyone may get an F.

Any form of cheating will be dealt with harshly. At a minimum, the examination or assignment will receive a score of zero, so a passing course grade will require strong performance on all other work. I may also request a University Disciplinary and Honor Code Committee hearing which could result in suspension or expulsion.

University and Department Policies: Your work in this course is governed by the UAF Honor Code. The Department of Mathematics and Statistics has specific policies on incompletes, late withdrawals, and early final exams which can be found at

`http://www.dms.uaf.edu/dms/Policies.html`.

If you have any disabilities that I should know about, you should bring them to my attention soon so that we can work with the Office of Disability Services to set up any necessary accommodations.

Tentative Schedule: The following is only approximate, and may be modified as the semester progresses.

Week	Starting date	Material to be covered
0,1	Jan. 17, 22	Chapter 1, AK CIVIL RIGHT DAY
2	Jan. 27	Chapters 1,2
3	Feb. 3	Chapter 2
4	Feb. 10	Chapters 2,3
5	Feb. 17	Chapter 3
6	Feb. 24	MIDTERM EXAM 1,Chapter 4
7	March 3	Chapter 4
8	March 10	Chapter 4, 5
	March 17	SPRING BREAK
9	March 24	Chapter 5
10	March 31	Chapters 5,6
11	April 7	Chapter 6, MIDTERM EXAM 2
12	April 14	Chapter 7,
13	April 21	Chapter 7, SPRING FEST
14	April 28	Catch up
15	May 5	Catch up, FINAL EXAM