MATH 172 **Fall, 2007**

Mathematical Modeling for the Life Sciences

Instructor. Matt Miller, office LeConte 300I (also check LC 411), hours: MW 3:00-4:30, Tu 2:00-3:30, and by appointment, phone: 777-3690, e-mail: `miller@math.sc.edu`, web: `http:// www.math.sc.edu/ ~ miller/172` . Notice that these are ordinary email and website addresses, NOT accessed through Blackboard.

Text. Required: *A Biologist's Guide to Mathematical Modeling in Ecology and Evolution* by Sarah Otto and Troy Day, Princeton University Press, 2007. This is a big, fat, hardcover, kind of scary looking book, and in fact it is intended for a year long course. It has everything we need and more, so if you plan to one day take MATH 523, BIOL 301, 552, or 763, hang onto it. It also contains some genuine biology. In the meantime we will be very selective in what we cover. At $65.00 on Amazon.com it is a real bargain. You will also need a graphing calculator (TI-83 preferred) that can handle sequences (recurrence relations, discrete dynamical systems, these all mean the same thing).
Recommended (if you can get it cheaply): *Elementary Mathematical Modeling* by J. Sandefur, Thompson Brooks/Cole, 2003. This book has been used for this course for several years, but it lacks a lot of material that has been relegated to handouts, and it is surprisingly expensive for a thin paperback (on Amazon.com it lists at $105.95 new, and from $23.95 used). It is, however, genuinely elementary.
Recommended: If you have your MATH 122 or 141 textbook, this will be an extremely useful resource.

Prerequisite. You must have earned a grade of C or better in MATH 122, 141, or an equivalent course to be approved by the instructor.

Overview. Unless you have taken MATH 122 here at USC-Columbia you will possibly find that this course is very different from other math courses that you have taken. We will be less concerned with the mechanical aspects of computation, and more concerned with why we want to do these calculations. We form a mathematical model of a changing real world situation, such as population growth, use a variety of methods to analyze it, and then interpret our calculated results in the context of the original problem. We will analyze problems by using a blend of verbal, pictorial, numerical, graphical, and analytic methods (manipulation of formulas). Modeling is more comprehensive than problem solving; we will learn how models are built, as well as how to "read them". One of the goals of the course is to enable you to look at scary formulas and to be able to dissect them into small and comprehensible pieces, so that even if you don't "do the math" yourself, you will be able to follow what has been done. Finally, in the real world, solutions must be communicated effectively, both in writing and orally, and you will some practice doing this.

Course content. We begin with an introduction to the whole idea of modeling a system (why do it?), how to build models starting with really simple ones and gradually building up to more complex ones, and how to interpret models that you can pull off the shelf. Models come in two flavors: discrete and continuous; we will explore how these are similar, how they are different, and why one might chose one over the other. The discrete ones are usually called difference equations; the continuous ones are called differential equations (DE's) and these you have already been solving in your calculus classes! Every time that you concluded something about a function from information about its rate of change you were actually solving a DE. One of our main tools will be the study of the equilibria (stationary values) of a model, what these are, how to compute them, how to determine if they are stable or not, and how they are related to the long term behavior of a system. Put crudely, we want to use models make predictions such as whether a population (or an epidemic) will boom (turn into a pandemic), go extinct (die out), or fluctuate around a certain level. This material is found in chapters 1–6 of the text. Next we will learn a little bit about matrices and vectors, emphasizing the intuitive geometric point of view, which is found in Primer 2 of the text, and then go on to selected topics from chapters 7, 8, and 10. (This also happens to be what the authors recommend in their preface.) All along we will work with tables of data, or verbal descriptions of problems, to build our models, and we will use our calculators to make educated guesses about the **qualitative behavior** of the solutions You will be expected to **gradually recognize for yourself** when the use of technology is appropriate, and when hand computation and exact algebra or calculus is called for.

Grades. Three major tests will be given, each worth 100 points, on Friday, 21 September (day 12), Friday, 26 October (day 26), and Monday, 3 December (day 40). At least seven ten-point quizzes will be given; the six highest scores will be counted. **No make-ups will be given for quizzes**, but there will be an opportunity on Reading Day (Saturday, 8 December) to take a make-up exam to replace your lowest exam score (a 0 if you missed an exam, but it could be any low score at all); this optional exam will only be counted if it helps your average. There will be two projects to be done in groups of size three or four; the first will be worth 30 points, where you will kind of get your feet wet analyzing a problem and presenting your conclusions in a well-crafted report; the second, done with a different set of partners, will be worth 50 points (it will be harder and my expectations will be higher). Due dates are Friday, 28 September (day 15) and Monday, 19 November (day 36, just before the Thanksgiving Break). Both the quality of the math and the exposition will be weighed; each group turns in a single write-up, and all members receive the same score. **No late projects will be accepted**, and the entire group will be assigned a score of 0. A total of 440 points may be earned:

Exams	300	
Quizzes	60	(best six)
Group projects	80	

Letter grades will be announced separately for each exam, and for the overall project and quiz totals. They will generally fall close to the scale 85–100 A, 75–84 B, 65–74 C, 55–64 D, below 55 F, but will vary up or down. Note that the deadline to drop this course without a grade of WF is Thursday, October 4; you should have a pretty good idea before then how you are doing.

Collaboration. One of the goals of this course is to learn how to communicate mathematical ideas. You will be expected to work with one another in class and on projects. However, you will have to take the exams individually, so don't get too dependent upon one another. According to the USC Student Handbook code of student academic responsibility, "**the first law of academic life is intellectual honesty.**" I expect this of all of you. If you are ever in the least bit uncertain about the ground-rules, ask for clarification!

Attendance. Regular attendance is crucial for success in this course. Ten bonus points will be awarded for perfect attendance and 5 for only one absence. No excuses will be considered in this regard. This class has 42 meetings; university policy states that if more than 10% of the meetings are missed, whether excused or unexcused, then the instructor may impose a penalty. I intend that this be a very rich and varied class, often with non-lecture activities. If you feel that a class is nothing more than a series of exams and some assignments to be turned in, with attendance optional, then this is not the class for you. If you miss 6 or more class sessions, I will lower your grade by half a grade point (from an A to a B+, or a C+ to a C, for example), and if you miss 8 or more classes, your grade will drop by a full grade point. If you do miss a class, you can find homework and a very brief synopsis on the class home page `http://www.math.sc.edu/~miller/172`. Be aware that I often take attendance silently: if you don't turn in a quiz, or I pass back a quiz or exam and you do not pick it up, I will assume you were not in class; so if you come in late you should always check to see if I have marked you absent.