MA565: Mathematical Models in the Life Sciences (Spring 2008)

Instructor: Mark Kramer (mak@bu.edu), 3-1493, 111 Cummington St, Room 239
Course Hours: 10-11 AM / MWF / 111 Cummington / MCS 149
Office Hours: 11-12 AM MF, 12-1 PM W / 111 Cummington / Room 239 or by appt.
Textbook: Edelstein-Keshet (2005), *Mathematical Models in Biology*.
Course Website: math.bu.edu/people/mak/MA565
Prerequisites: Introductory differential equations or consent of instructor.

In this course, we will study the application of mathematics to problems in biology, with particular emphasis on questions arising from ecology and neuroscience. In doing so, we will typically start by proposing a problem and then develop methods to solve this problem. We will not prove theorems or perform rigorous derivations in this course; instead, we will seek out and learn to use the tools common in mathematical biology. Upon finishing this course, you will have developed many skills fundamental in mathematical biology research and more rigorous studies of applied dynamical systems. Those students interested in a more mathematical approach to this field might consider MA771.

Course goals: To develop skills in the construction, analysis, and interpretation of mathematical models in biology. We will focus on dynamical systems approaches, including quantitative analytic results and qualitative graphical / computational results.

Homework / Exams / Projects: Homework will be assigned every one or two weeks, and due one or two weeks following the assigned date. You are encouraged to work in groups, but must submit your own written or typed solutions to each problem. Please arrange with me late assignment submissions in advance of the due date. Two in-class quizzes will occur at approximately 5 weeks and 10 weeks into the semester. A final research project is also required (details below). There will be no final exam in this course.

Semester Project: Twenty five percent of your final grade will be based on a research project. You are encouraged to work in groups of two or three. Expectations for this project are high --- you are expected to show initiative in learning mathematical biology material, and you are expected to convey what you have learned to us.

You are free to choose a topic from your personal area of interest, as long as there is a firm connection to this course. You might consult the relevant literature, or perhaps choose a topic that we have not covered in class from our text. I will of course be available for advice or aid in working through your chosen topic.

I suggest that you begin your research as soon as you feel you have enough of a background from this course. You will be graded in part on the originality of the topic chosen, the ambitiousness of the topic, the quality of the written report (and time permitting poster presentation) and the amount of mathematics learned. A one-page project prospectus, complete with the names of the members of your group will be due in late March.

Grades: Your grade for this course will be based on your homework scores (50% of total grade), your quiz scores (Quiz 1 = 10% and Quiz 2 = 15% of total grade), and your final research project (25% of total grade). You must complete the research project to pass the course. Your final grade will be based on the percentage of points you score: A > 90% > B > 80% > C > 70% . . . .[1]

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[1] Please Note: Undergraduates are responsible for knowing, and abiding by, the provisions of the CAS Academic Conduct Code, which is posted at: http://www.bu.edu/cas/academics/programs/conductcode.html

Similarly, graduate students are responsible for knowing, and abiding by, the provisions of the GRS Academic Conduct Code, which is posted at: http://www.bu.edu/grs/academics/resources/adp.html.

Violations of the code are punishable by sanctions including expulsion from the University.

Course Schedule: (tentative):

Week 1: Introduction / discrete models.

Week 2: Discrete model examples (red blood cells) and basic linear algebra review.

Week 3: Nonlinear difference equations (the logistic map).

Week 4: Graphical methods for discrete systems.

Week 5: Examples (waves of disease, density dependent growth, population genetics).

---- Quiz 1 ----

Week 6: Continuous models (bacterial growth and density dependent growth).

Week 7: Continuous model examples (I&F neuron, bacterial growth in a chemostat).

Week 8: Chemostat example continued and review of linear ODEs.

Week 9: Vacation

Week 10: Graphical methods for continuous systems.

---- Quiz 2 ----

Week 11: Applications of graphical methods (chemostat, predator-prey, competition)

Week 12: Applications of graphical methods (FitzHugh-Nagumo model, coral reef ecology)

Week 13: Oscillations and limit cycles (Poincare-Bendixson, index theory, Hopf bifurcation)

Week 14: Bifurcation theory? Hodgkin-Huxley equations? Requested examples?

Week 15: More examples? Poster presentations?