BIO 480/680 – Introduction to Biological Modeling

Course Syllabus

**Instructor:** Paul J. Schulte, WHI-308, 895-3300, paul.schulte@unlv.edu.


**Course description:** This course will present an introduction to the use of mathematical models for studying biological processes and systems. Modeling will be developed as an additional or alternative experimental approach for studying biology. We will consider the usefulness of modeling as well as the associated pitfalls. Models will often be expressed as one or more mathematical equations, with solutions obtained through computer programs. Although some of the models will use previously developed software, students will also develop the ability to write simple computer programs for modeling. (3 credits)

**Additional resources:** Students in the course have the option to take advantage of material available through the internet. The course has a web page accessible with a web browser and may be found through the Department of Biological Sciences web page (see http://biology.unlv.edu) or directly at http://biology.unlv.edu/Schulte/BIO480/. This page contains project handouts, downloadable software, and other useful resources.

**Grading:** There will be three lecture exams (including final). The first two exams will each count for 20% of the grade and the final will be 30% of the grade. We will not have lab exams, but a short report will be required for each weekly project. The total lab report contribution to the grade will be 30%. The final exam (unlike the first two exams) will be somewhat comprehensive in that it will concentrate on the material from the last third of the course but will include some general concepts from earlier parts of the course. There will be a small number of “low-impact” quizzes (only a few points) during the semester. Graduate students (BIO 680) will conduct an additional project (10% of the grade).

**Class attendance:** The course covers a lot of material and much of it will be new to you. There will be readings and handouts, but a lot of information is only presented and explained during lectures. The projects (not to mention the exams!) will be difficult to complete if you do not make every effort attend all of the lectures.

**Project reports:** These reports need not be very long (a few pages), but should include three main sections: (1) an Introduction with a brief description of the model(s) being studied that week, (2) a Results section with numerical data or graphs, and (3) a Conclusions section summarizing what was learned from the model about that particular biological system or process. For the projects where you write your own programs, a listing of the program should be included as an Appendix. Reports must be typed.
These reports will be due at the end of the week following the lab; 1 point will be deducted for each week they are late.

**Computer programming**: For several of our exercises, we will write our own programs using the computer programming language C. Here are a few rules and suggestions for these activities:

- It is ok and sometimes useful to work with other students in the development of your programs. BUT, you must turn in your own program and project reports based on your own results and not some kind of shared copy of program, results, and/or report.

- Reviewing the programs of other students along with the sample programs available on the course web page can help you to learn programming and to develop the programs for our projects, but it will be essential that you understand the programs in terms of how they work and what each statement means - if you just copy and paste parts of sample programs or those of other students without understanding how it works and why, you will not learn programming!

- Sometimes students are tempted to get other people to write their programs for them – this is generally a bad idea, because you will not end up learning anything about writing programs yourself and you will not understand the ones you see in class or are asked about on an exam.

**Academic Honesty**: Academic dishonesty is defined by UNLV (see undergraduate catalog) to include any act that violates the academic processes of the university. These acts include, but are not limited to, cheating on an examination, stealing examination questions, substituting one person for another at examinations, falsifying data, destroying or tampering with or stealing a computer program or file, and plagiarism (using as one’s own the ideas or writings of another). The punishment recommended by UNLV for academic dishonesty may be a failing grade for the course and initiating a disciplinary review as described in the university’s rules and disciplinary procedures. The result of the review may be a warning, probation, suspension, or expulsion.

**Disability statement**: If you have a documented disability that may require assistance, you will need to contact the Disability Resource Center for coordination in your academics accommodations. The DRC is located in the Reynolds Student Services Complex in Room 137. The DRC phone number is 895-0866 (TDD-895-0652).

**Outline of Topics**

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
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<tr>
<td>1</td>
<td>Introduction. What is a model? Why are models useful? Modeling approaches and pitfalls. (Haefner, Ch 1)</td>
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<td>2</td>
<td>Programming for modeling (Intro to C language)</td>
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Lab 1: Computers & programming intro. (Simple population model).
   MLK Day – 19 January

3 The modeling process (Haefner Ch 2)
Lab 2: Logistic equation population growth.

4 Model development I - qualitative (Haefner Ch 3)
Lab 3: Two-species interactions - Love affairs model.

5 Model development II - quantitative
Exam I – 11 February.

6 Model development II - quantitative cont’d (Haefner Ch 4)
Lab 4: ModelMaker program introduction
   Presidents Day – 16 February

7 Compartment models
Lab 5: Aquatic system model (using ModelMaker)

8 Numerical methods I (Haefner Ch 6)
Lab 6: Euler’s method.

9 Numerical methods II (Haefner Ch 6)
Lab 7: Root-finding methods.

10 Organism – Environment interactions
Lab 8: Lizard energy budget.

11 Stochastic models – random numbers (Haefner Ch 10)
Lab 9: Computers and generating random numbers
Exam II – 23 March.

12 Stochastic models cont’d (Haefner Ch 10)
Lab 10: Random processes and population dynamics.

13 Spring break: 6 – 11 April.

14 Chaotic systems in biology (Haefner Ch 18)
Lab 11: Chaotic systems.

15 Computational genomics & proteomics (Haefner Ch20)
Lab 12: Sequence alignment methods.

16 Artificial life simulations
Lab 13: Avida program.

Final exam – Monday 4 May, 6:00 PM (Graduate student project due)