# Syllabus

# Mathematical and Computational Models in Biology

# Biol 553 / Math 553

# Fall 2019

**Introduction:**

Welcome! This course will introduce methods for developing and analyzing mathematical models of biological systems. We will cover a range of mathematical techniques and explore examples from various biological fields. You will learn these techniques both through lectures and by developing models in the lab Biol/Math 553L.

**Instructors:**

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Office hours: Wed 1:00-2:00pm Office hours: Tues 2:00-3:00pm

If you are unable to come during office hours meetings can be scheduled by appointment.

**Lecture:**

T, Th 12:30-1:45pm, Wilson 213

The co-requisite lab course (Biol/Math 553L) will reinforce ideas learned during the lectures and to give you experience writing programs to analyze biological problems. You will learn both Mathematica and MATLAB in the lab course.

**Textbook:**

The textbook (required), which is available in Student Stores, is:

*A Biologist’s Guide to Mathematical Modeling in Ecology and Evolution*

by S.P. Otto and T. Day, Princeton University Press, 2007.

**Evaluation:**

Grades will be determined in the following way:

Weekly take-home quizzes: 25%

Group project: 25%

Midterm: 20%

Final exam: 30%

*Quizzes*: We will hand out open-book take home quizzes on ~10 different Thursdays due at the beginning of class on the following Tuesday. You should work these quizzes independently under the UNC Honor Code.

*Midterm & Final*: There will be an in-class midterm exam and a final exam each composed of 6 to 10 medium length problems similar in style if not scope to the quiz questions.

*Group projects*: You will end the semester with a group project on a topic of your choice. This project will give you the opportunity to explore a biological question of interest in more depth. Groups will consist of approximately 4 students and will be formed towards the beginning of October (see Schedule). Brief abstracts describing the topics for your projects will be due two weeks later.

Your group project will be presented in four ways: 1) an in-class presentation and brainstorming session for your model (ungraded), 2) in-class presentations of the complete project in mid-November, 3) a write-up of your Methods and Results, along with your code and presentation slides, due on Nov. 20, and 3) a final full write-up of your project, including all code, due Dec 6.

The group project is worth 25% of your Biol/Math 553 grade (the coding implementation of the project also forms part of your lab grade – see the Biol/Math 553L syllabus). This 25% will be broken down as follows: 6% for your in-class presentation of the complete project, 6% for your final write-up, and 13% for the logic, construction, and analysis of your model (excepting code implementation). We will determine an initial grade for the logic, construction and analysis portion from the in-class presentation and the material due on Nov 19. You will then have a chance to earn up to half of the remaining points for this section back, at our discretion, by correcting or improving your model after this initial assessment (we will determine how well you corrected this by the final write-up).

**Course Schedule**

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| --- | --- | --- | --- |
| Date | Lecture | Topic | Reading |
| Aug 20, 22 | 1, 2 | Introduction and how to construct a model | Ch. 1, 2 up to 2.6 |
| Aug 27, 29 | 3, 4 | Introductory Discrete and Continuous models | Ch. 3 up to 3.5 |
| Sept 3, 5 | 5, 6 | Deriving models & graphical analysis II, | Sec 3.5, Ch. 4 |
| Sept 10, 12 | 7, 8 | Equilibria and stability – one variable I | Ch. 5 |
| Sept 17, 19 | 9, 10 | Equilibria and stability – one variable II, transformations | Ch. 6 |
| Sept 24, 26 | 11, 12 | Equilibria and stability analysis of models with multiple variables I | Ch. 7, 8 |
| Oct 1, 3 | 13, 14 | Equilibria and stability analysis of models with multiple variables II; In-class modeling exercise | Ch. 7, 8 |
| Oct 8, 10 | MT, 15 | Midterm Tuesday, Oct. 8;  Paper discussion Oct. 10; *Projects* – form groups (Oct. 10) |  |
| Oct 15 | 16 | Linear Models and Class Structure; *Projects* – abstracts due at end of class (Oct. 16) | Ch. 10-10.4 |
| Oct 22, 24 | 17, 18 | Equilibria and stability analysis, nonlinear models with multiple variables I(both days) | Ch. 8 |
| Oct 29, 31  ­ | 19, 20 | *Projects* – Presentation of preliminary project & model equations in class; Equilibria and stability analysis, nonlinear models with multiple variables II. | Ch. 8 |
| Nov 5, 7 | 21, 22 | *Projects* – Project in-class workday; General solutions and transformations – models with multiple variables I | Ch. 9 |
| Nov 12, 14 | 23, 24 | Timescale separation |  |
| Nov 19, 21 | P, 27 | *Projects* – full presentations (Nov 18 & 19); slides, code, Methods & Results due Nov. 19  Markov Models | Ch. 14 – 14.3 |
| Nov 26 | 25 | Periodic behavior + Poincare, Bendixson & Hopf | Ch. 11 – 11.4 |
| Dec 3 | 26 | 2-point cycles | Ch. 11 – 11.4 |
| Dec 4 | P | *Projects* – final write-up due Dec. 4 at 5pm |  |
| Dec 6, noon |  | FINAL (date unknown at this time) |  |