MATH 484/684: Math Methods of Bio Processes: 3 credits — Fall 2015

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Online eval	https://www.ndsu.edu/pubweb/~novozhil/Teaching/evaluation_form.htm You can use this form to submit anonymous comments any time during the course.
Phone	(701) 231-8680
Lecture hours	MWF 2:00pm–2:50pm (NDSU Ladd Hall, Rm 114)
Office hours	MWF 9:00am–10:00am (or by appointment)
Textbook	Detailed lecture notes will be provided (see the course web page). Linda J. S. Allen, *An introduction to Mathematical Biology*, Pearson, 2007 Another useful (but not necessary) text is Steven H. Strogatz, *Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering*, Westview Press, 2014, Second edition (the first edition will also work)
Prerequisites	MATH 266
Course Description	This course provides an introduction to mathematical methods in biology. In particular, the elements of the dynamical systems theory will be presented. The focus is on development of the pertinent mathematical theory, and the biological applications are used mainly to illustrate mathematical concepts.

Course Objectives and Schedule

Mathematical modeling in biology requires a wide variety of mathematical tools. One of the main such tools is the dynamical systems theory. Therefore, the main objective of the course is to learn the basics of the mathematical theory of deterministic dynamical systems. The biological applications will serve to motivate and illustrate mathematical techniques presented in the course. I tentatively plan to include the following topics:

- *Mathematical models of the population growth.* Quantitative (or geometric) theory of ordinary differential equations (ODE). Phase space, orbits, equilibria, stability. Elementary bifurcations. Biological application: Why do insects have population outbreaks? (Weeks 1-3)
- *Mathematical models of interacting species.* Phase portraits. Stability by linearization. Types of ecological interactions. Stability and Lyapunov functions. Limit cycles. Bendixson–Poincaré theory. Biological application: Why do predators and prey sometimes exhibit periodic oscillations? (Weeks 4-9)
- *Discrete dynamical systems.* Maps from $\mathbf{R}$ to $\mathbf{R}$. Discrete dynamical system. Orbits, equilibria, periodic points. Logistic equation and chaos. Bifurcations. Lyapunov exponents. Discrete and continuous dynamical systems. Biological application: Do insect populations exhibit chaos? (Weeks 9-12)

- *Modeling the age heterogeneities.* Linear discrete dynamical systems. Perron–Frobenius theory and nonnegative matrices. Biological application: Do we have a fundamental theorem in demography? (Weeks 13-15)

  If time permits I will include a short discussion of

- *Evolutionary game theory.* Classical game theory, Nash equilibria. Evolutionary game theory and the replicator equation. Biological application: How do altruists appear?

- *Modeling the space heterogeneities.* Random walk and diffusion equation. Traveling wave solutions. Reaction–diffusion systems. Biological application: How big does an island have to be to support a population?

Class Attendance Class attendance is expected. The students are solely responsible for missed handouts or announcements made during the lectures.

Homework and Quizzes Homework problems will be posted on the course web page approximately once a week. Starting from week two these homeworks will be collected and graded. Group work on homework problems is encouraged, however, you must turn in your own writeups of all problems. Also, any hints or help from other instructors, your friends or relatives, or from any online sources have to be acknowledged and properly referenced.

Exams There will be one midterm exam and a comprehensive final exam at the end of the semester. The tentative date for the midterm exam is October 16th. The final exam is scheduled for Monday, December 14th, 8:00am–10:00pm. Make-ups for the exams are possible in case of a legitimate (documented) excuse. Please contact me well in advance to arrange for a make-up.

Grading The grading of the course will be based on the homework (40%), midterm exam (30%), and final exam (30%). The student will get A/B/C/D/F with the thresholds 90/80/70/60.

Academic Responsibility and Conduct The academic community is operated on the basis of honesty, integrity, and fair play. NDSU Policy 335: Code of Academic Responsibility and Conduct applies to cases in which cheating, plagiarism, or other academic misconduct have occurred in an instructional context. Students found guilty of academic misconduct are subject to penalties, up to and possibly including suspension and/or expulsion. Student academic misconduct records are maintained by the Office of Registration and Records. Informational resources about academic honesty for students and instructional staff members can be found at `www.ndsu.edu/academichonesty`.

Any student found guilty of academic dishonesty will receive a grade of 0 for the homework assignment, or quiz, or exam in question. In addition, every such student will be reported to the Chair of Mathematics, the Dean of their major college, the Dean of the College of Science and Mathematics, the Provost, and the Registrar. The Registrar will add any such student to NDSU's Student Academic Misconduct Database. (Multiple entries in this database may result in additional sanctions from NDSU.)

Special Needs Any students with disabilities or other special needs, who need special accommodations in this course, are invited to share these concerns or requests with the instructor and contact the Disability Services Office (`www.ndsu.edu/disabilityservices`) as soon as possible.