Course: M 414 Deterministic Models / Spring 2019 / MWF: 10:00 – 10:50 a.m. Room Math 306

Instructor: **Professor Leonid Kalachev**

Office hours: MWF 10:00 AM – 11:00 AM or by appointment (Room Math 309).

Textbook: Gerda de Vries, Thomas Hillen, Mark Lewis, Birgitt Schönfisch, Johannes Müller, *A Course in Mathematical Biology: Quantitative Modeling with Mathematical and Computational Methods*, Monographs on Mathematical Modeling and Computation, Book 12; Philadelphia, SIAM, 2006. ISBN: 9780898718256 ; ISBN: 0898716128 (paperback).

Purpose of the Course: To provide an in-depth introduction to modeling in terms of ordinary and partial differential equations, and difference equations. The emphasis is on the hands-on practical approach to modeling processes in population biology, ecology, propagation of infectious diseases, chemical and biological kinetics, and other applications. In addition to model formulation and analysis, the basics of model parameter identification using the data will be addressed. For the final projects the students working in the labs will be encouraged to use their own data and / or work on the problems that are of direct relevance to their research.

Course Description: 3 credit hours. Prerequisites: M 263 or M 311, or consent of instructor. Mathematical content involves material on linear and nonlinear difference and differential equations: qualitative and quantitative methods, stability, phase–plane analysis, oscillatory behavior, limit cycles, chaos, eigenvalues and eigenfunctions. Emphasis on models in biology.

Intended Audience: Undergraduate and graduate students from the Departments of Mathematical Sciences, Wildlife Biology, Ecology, Chemistry, Neuroscience, Biology, Psychology, Physics, Geology, Forestry, and Computer Science.

Learning Goals: The students will learn

- To formulate models from various scientific fields (with an emphasis on biology) in terms of ordinary differential equations (ODEs), difference equations (DEs), and partial differential equations (PDEs).
- Advanced techniques of quantitative analysis of ODEs, DEs, and PDEs.
- Advanced techniques of qualitative analysis of ODEs, DEs, and PDEs.
- To develop a way of thinking oriented towards modeling.

Course Format: The format is a mixture of lectures, problem solving sessions, computer lab sessions (with the templates of modeling programs provided), group learning activities, and discussions.

Use of Technology: The course material will be illustrated with MATLAB software (a brief introduction to programming in MATLAB will be provided); students are also encouraged to use Maple, Excel, Mathematica, or any other software packages.

Assessment: Several homework assignments will be given during the semester (20% of the final grade) as well as two midterm exams (20% of the final grade each). The final projects (30% of the final grade) will involve both individual and group work; the students will be required to make oral presentations and submit written reports. Some material will only be given in class, so the attendance is very important for

understanding of the course material. Thus, the course grade will also be based on attendance (10% of the final grade).

Grading intervals:

A: [85%, 100%]; B: [70%, 85%); C: [55%, 70%); D: [40%, 55%); F: [0%, 40%).

Add / Drop policies: The last day to add/drop a course (via CYBERBEAR and without a fee) is January 31, 2019. From February 1 and until April 26, 2019 these changes are allowed to be done only by Petition (electronic or paper form; $10 fee applies), which requires the signature and approval by the professor. The final deadline for all changes is April 26, 2019.

Academic Integrity: All students must practice academic honesty. Academic misconduct is subject to an academic penalty by the course instructor and/or a disciplinary sanction by the University. All students need to be familiar with the Student Conduct Code. You can find it in the "A to Z Index" on the UM home page.

Disability modifications: The University of Montana assures equal access to instruction through collaboration between students with disabilities, instructors, and Disability Services for Students (DSS). If you think you may have a disability adversely affecting your academic performance, and you have not already registered with Disability Services, please contact Disability Services in Lommasson Center154 or call 406.243.2243. I will work with you and Disability Services to provide an appropriate modification.

Topics and Dates (tentative): The main content will correspond to the material presented in Chapters 1 - 4 of the text book. Some parts of Chapter 7 (on estimating model parameters), Chapters 9 and 10 (particular projects' description and analysis) will be addressed. MATLAB tutorial will be presented in class; MAPLE tutorial is included in Chapter 8 of the textbook (may be used as an alternative software package).

January 11 – February 15, 2019: Introduction. Models formulated in terms of linear and nonlinear difference (discrete time) equations. Chapters 1 and 2.

February 20 – March 22, 2019: Models formulated in terms of linear and nonlinear ordinary differential (continuous time) equations. Chapter 3.

April 1 – April 26, 2019: Models formulated in terms of partial differential equations (if time permits). Chapter 4. Modeling projects.