COURSE: **Models in Biology**
Math 405/EEB 406

TIME & PLACE: 11:30-12:205 MWF *Spring 2023*
Humanities and Social Sciences 104

INSTRUCTOR: Sergey Gavrilets
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OFFICE HOURS: Thursday 3:00-4:00, 403B Austin Peay or by appointment

Major goal of the course: introduce the students to a variety of mathematical models used in biological sciences.

Texts: Additional reading will be suggested.

GRADES: Course grade will be based on the following:

- Quizzes: 100 points,
- Midterm Exam (March 10, Friday): 100 points,
- Comprehensive Final Exam: 150 points.

I intend to follow the following grading curve: 0-50% **F**, 51-60% **D**, 61-70% **C**, 71-75% **C+**, 76-85% **B**, 86-91% **B+**, 92-100% **A**.

COMMENTS:

Homework assignments will be generally given once a week. I will not grade them but the quizzes and exam problems will generally be based on the homework problems.

There will be 11-12 open book quizzes usually given on Fridays. There will be no make-up quizzes. Two quizzes with the smallest scores will be dropped.

Use of books and notes will not be allowed on any exam.

The make-up exam will only be considered to be given under extreme circumstances that are to be documented in writing. Such conflicts must be brought to my attention at the earliest feasible time

In order to be considered at all, what you hand in should be neat, coherent and easy to read.

Regular attendance is strongly advised. You will be held responsible for all material presented and discussed, regardless of whether or not you were present.

Computer packages *Matlab* and *Maple* will be extensively used in class, for quizzes, and for homework. UT has campus-wide licenses which allow you to get copies of the software.

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Tentative syllabus

1. Introduction to the course
   a. Examples of questions and processes we will be looking at
   b. Some technical/mathematical stuff

2. Ecological modeling: ~3 weeks
   a. Simple population growth: exponential, logistic
   b. Exact solutions
   c. Quantitative analysis: sign of derivative
   d. Discrete vs. continuous time models
   e. Non-equilibrium dynamics in discrete-time models
   f. Lotka-Volterra interacting populations:
      i. competition
      ii. predator-prey
      iii. mutualism
   g. Technical stuff
      i. Phase-plane analysis, equilibria, stability
      ii. Matlab
      iii. Maple

3. Modeling infectious diseases: ~1 week
   a. SIS models
   b. SIR models
   c. SIRS models

4. Population genetic modeling: ~3 weeks
   a. Basic equations (including “replicator equation”)
   b. Wright's equation
   c. Dynamics predicted: equilibria; time-scales
   d. Additional evolutionary forces: mutation, drift, migration
   e. Quantitative characters; Lande's equation
   f. Fitness landscapes and gradients
   g. 2-locus models
   h. Frequency-dependent selection
   i. Random genetic drift

5. Modeling cultural evolution ~3 weeks
   a. Differences b/w genetic and cultural evolution
   b. vertical transmission
   c. oblique and horizontal transmission
   d. voter model
   e. assortative mating/interactions
   f. imitation dynamics
   g. Rogers paradox

    h. conformism biases

6. Modeling social evolution ~3 weeks
    a. Animal conflict
    b. Dyadic games: hawk-dove, snowdrift, Prisoner's dilemma, etc
    c. Altruism and inclusive fitness: Hamilton's Rule, relatedness, kin selection
    d. Reciprocity
    e. Collective action problem
    f. Tragedy of the Commons
    g. Volunteer's dilemma
    h. Group selection and warfare