

Fall 2017

Math 304L – Mathematical Modeling: Deterministic Models Lab (1)

**Course Description:** Optional laboratory for Math 304.

**Prerequisite:** Math 304 or concurrent, or consent.

**Time:** At least 100 minutes per week working on programming exercises or on a research project; 50 minutes per week in individual or group meetings with the Instructor.

**Lab:** Students will learn to use Matlab (or a Matlab clone, such as Octave). For approximately two-thirds of the semester, students will work on weekly programming exercises. Time in the Mathematics Department computer lab will be made available for students to work on their exercises and projects, but they will also be expected to download the program (Octave is free) and work on their own. Their Instructor will consult with them weekly, either in the lab or in his/her office. Around the middle of the semester students will choose a project, after which students will spend progressively more time working their project. Part of the project will involve writing and running programs, and the lab will continue to be available for this purpose.

**Modeling Project:**

The project will consist of choosing a model to study from a published research paper (or possibly an extension of a model in the textbook), simulating the model using Matlab (or Octave), and reproducing results from the paper. In addition, students will formulate a question that is not fully addressed in the paper, and modify the model to study it, or extend the analysis of the behavior of the model beyond that of the paper. A more open-ended project that requires formulation of a new model is also possible. Students will be required to turn in a written report on their project.

**Suggested Textbooks:**

There is no required text for the course. Students will be given handouts explaining the basics of Matlab programming. There are online expositions of Matlab freely available, e.g. <https://people.math.osu.edu/overman.2/matlab.pdf>; however these are not required and most students don't find they need them.

**Course Outline:**

Week 1 Introduction to Matlab.

Week 2 Two and three dimensional plots.

Weeks 3-4 Numerical solution of ordinary differential equations; plotting solutions and slope fields.

Weeks 5-6 Use of m-files. The discrete logistic function: cobweb plots, periodic points, bifurcation diagrams.

- Weeks 7-8 Matrices, eigenvalues and eigenvectors. Application to population projection matrices; finding the stable age structure and the sensitivity matrix.
- Week 9 Study of predator-prey models: Lotka-Volterra and Rosenzweig-MacArthur models. Begin looking at projects.
- Week 10 Use of the John Polking's pplane matlab program to efficiently create vector fields and phase portraits of systems of two autonomous differential equations. Discuss possible projects with Instructor.
- Week 11 More examples of phase portraits. You must commit to a project and inform your instructor.
- Weeks 12-16 Work on project; consult weekly with Instructor.
- Week 16 Projects due by last day of regular classes.

### **Student learning objectives**

Upon successful completion of Math 304L, the student will be able to write programs to assist in analyzing the behavior of deterministic mathematical models. They will also be able to read a research paper containing deterministic mathematical models, and understand and be able to explain the assumptions behind the models.

### **Program objectives**

Math 304L is a junior level course in writing programs to analyze the behavior predicted by deterministic models. This is an important skill in the application of mathematics to all fields of science. This course promotes our goal that our students learn, understand, and be able to apply several mathematical topics at the junior and senior level, and that our students acquire the ability and skills to apply mathematics to other fields. The approach emphasizes computation and application over theory. The course material is geared for both math and science students, so fulfills a service role as well as part of our major program.