Department of Mathematics
Pomona College

Math 183. Mathematical Modeling
Course Outline
Spring 2020

Time and Place: MWF 10:00 am - 10:50 am, Millikan 2113

Instructor: Dr. Adolfo J. Rumbos

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Office Hours: TR 9:00 am -10:00 am, or by appointment.

Prerequisites: Linear Algebra and Ordinary Differential Equations

Course Description. The main goal of this course is to provide opportunities for students to construct and analyze mathematical models that arise in the physical, biological and social sciences. Mathematical models are usually created to obtain understanding of problems and situations arising in the real world; other times, the main goal is to make predictions or to control certain processes; finally, some models are created to aid in decision making.

Construction of a mathematical model consists of translating a real world problem into a mathematical problem involving parameters, variables, functions, equations and/or inequalities. Analysis of the model involves the solution (if possible) of the mathematical problem through logical, algebraic, analytical or computational means, and assessing what the solutions imply about the real situation under study. If an analytical or computational solution is not possible, computer simulations can sometimes be used to study various scenarios implied or predicted by the model.

Analysis techniques can be drawn from many areas of mathematics. In this course, it is assumed that students have a good working knowledge of Calculus, Linear Algebra and Ordinary Differential Equations. These areas are adequate for the analysis of some models. However, many modeling situations require the use of some probability theory and optimization techniques. These mathematical topics will be covered in the course. In calculus and differential equations courses, students have been exposed to some *continuous* models. In this course, we will also introduce students to *discrete* models as well.

Course Structure and Requirements. The course will be structured around a series of case studies that will provide ample opportunity for students to learn about (and to practice) the development and analysis of models raging from the *discrete* to the *continuous*, and from the *deterministic* to the *stochastic* (or probabilistic), and in many cases involving *mixed-type* modeling. Homework problems will be assigned at every meeting and collected on an alternate basis. There will be two midterms. Students will also be required to work in teams of two or three on a modeling project in the last part of the course. The project consists of a term paper describing the construction and analysis of the model. In addition, students will be required to give a formal presentation on the modeling project at the end of the semester.

Grading Policy. Grades will be based solutions to assigned problems, exams, the term paper and the modeling project presentation. The overall score will be computed as follows according to the following distribution:

Homework	20%
Exams	50%
Presentations	15%
Modeling term project	15%

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Tentative Schedule of Topics and Presentations

Date		**Topic**
W	Jan. 22	Introduction to the process mathematical modeling
F	Jan. 24	Case Study: Bacterial Growth in a Chemostat
M	Jan. 27	Nondimensionalization
W	Jan. 29	Nondimensionalization (continued)
F	Jan. 31	Problems
M	Feb. 3	Case Study: Modeling Traffic Flows
W	Feb. 5	Traffic flow models (continued)
F	Feb. 7	Problems
M	Feb. 10	Analysis of a traffic flow model
W	Feb. 12	Method of characteristics
F	Feb. 14	Method of characteristics (continued)
M	Feb. 17	Shock waves
W	Feb. 19	Shock waves (continued)
F	Feb. 21	Problems
M	Feb. 24	Problems
W	Feb. 26	Review
F	Feb. 28	**Exam 1**
M	Mar. 2	Case Study: Modeling bacterial mutations
W	Mar 4	Stochastic models
F	Mar. 6	Probability
M	Mar. 9	Random variables and distributions
W	Mar. 11	Random variables and distributions (continued)
F	Mar. 13	Random processes
M	Mar. 16	*Spring Recess*
W	Mar. 18	*Spring Recess*
F	Mar. 20	*Spring Recess*
M	Mar. 23	Random processes (continued)
W	Mar. 25	Random processes (continued)
F	Mar. 27	*Cesar Chavez Recess*

Date		**Topic**
M	Mar. 30	Modeling diffusion
W	Apr. 1	Modeling diffusion (continued)
F	Apr. 3	Modeling diffusion (continued)
M	Apr. 6	Problems
W	Apr. 8	Review
F	Apr. 10	**Exam 2**
M	Apr. 13	Modeling Project
W	Apr. 15	Modeling Project
F	Apr. 17	Modeling Project
M	Apr. 20	Modeling Project Presentations
W	Apr. 22	Modeling Project Presentations
F	Apr. 24	Modeling Project Presentations
M	Apr. 27	Modeling Project Presentations
W	Apr. 29	Modeling Project Presentations
F	May 1	Modeling Project Presentations
M	May 4	Modeling Project Presentations
W	May 6	Modeling Project Presentations