Math 87, Section 01 Tufts University
Modeling and Computing Department of Mathematics Fall 2012

Course Website: `http://neumann.math.tufts.edu/~scott/math87_F12`.

Recommended Materials: *Matlab & Simulink Student Version - Release 2011a*, available from the bookstore or from `http://www.mathworks.com/academia/student_version/index.html` . The homework in this course will require you to do some programming exercises; if you are not already familiar with another programming language (and even if you are), then it is probably easiest to do these in Matlab. All Tufts students have access to Matlab in the ITS Computing Center at Eaton Hall, but the student version will allow you to do the assignments on your own computer. Free alternatives (that require more work to get running) include doing these exercises in Octave or Python.

Academic Integrity: While there are no exams in this class, students are required to abide by the university guidelines on academic integrity. For full details, see
`http://uss.tufts.edu/studentaffairs/policies/campus/academicintegrity.asp` .

Disability Services: If you are requesting an accommodation due to a documented disability, you must register with the Disability Services Office at the beginning of the semester. To do so, call the Student Services Desk at 617-627-2000 to arrange an appointment with Linda Sullivan, Program Director of Disability Services.

Sample Problems: This is a class about solving real-world problems using the tools of mathematics. Some problems we will learn how to solve are:

1. Given a known growth rate of a population of fish, how much fishing should be permitted to maximize the long-term profit of the industry? How sensitive is this to the growth rate of the population? How should the strategy change if the population is unnaturally low due to past over-harvesting?
2. How should you decide how to "spend" a limited resource, such as the time of skilled tradespeople? How much should you be willing to pay to increase your supply of such a resource?
3. Under what conditions can you find "perfect" matches between members of different groups, such as partners for a dance, roommates in a college dorm, or tasks and workers who can perform them? How do you optimally distribute tasks to be done among individuals with different skills?
4. How do you schedule the individual pieces of a complex project, like renovating a laboratory or building a highway interchange?
5. How can we "rank" webpages for relevance to a given topic?
6. How should you schedule paying off a debt (such as a mortgage or credit card) depending on your expected income over time?

Learning Objectives: This course satisfies the following Mathematics Department Learning Objectives:

1a: Working understanding of basic insights and methods in a broad variety of mathematical areas, including but not limited to calculus, linear algebra, real analysis and abstract algebra

1e: Using mathematics to think about problems outside of mathematics

4a: Searching the literature, and organizing information from disparate sources

5a: Computer literacy

6a: The ability to solve problems involving undergraduate mathematics, including the ability to formulate and present a mathematical proof.

Course Work and Grading: This course will be focused on the development of problem-solving techniques based on applying mathematical ideas and computational principles. There will be no exams. Instead, there will be weekly homework assignments, two midterm projects, and a final project. Your final percentage grade in the course will be computed as 40% for homework, 15% for each midterm project, and 30% for the final project.

Late Policy: All homework assignments are due at the beginning of the class on the date specified. Late homework will be penalized by deducting 10 percent of the total grade per day late. For example, an assignment handed in before 1:30 pm on the day after it is due will be penalized 10 percent, while one handed in after 1:30 pm on the day after it is due will be penalized 20 percent. You are allowed two "freebies" in this system, so you may *either* hand in two of your assignments one day late each *or* one assignment two days late (but not both) without penalty. *No* late projects will be accepted.

Approximate Course Schedule:
9/4: Introduction
9/6: One-dimensional optimization, sensitivity analysis
9/11: Multi-dimensional optimization, Lagrange Multipliers, shadow prices
9/13: Intro to Matlab
9/18: Optimization using Newton's Method and Variants
9/20: Types of optimization, linear programming
9/25: Linear programming and fair division
9/27: Network flows and linear programming
10/2: The simplex algorithm
10/4: Duality and complementary slackness
10/11: Dual prices, integer programming
10/16: Branch and bound algorithms
10/18: Graph models, max flow and min cut
10/23: Bipartite graphs, matchings, selection problems
10/25: Scheduling problems, critical path method, Gantt charts
10/30: Finite-state machines, transition diagrams
11/1: Iteration matrices, eigenvectors, power iterations
11/6: Stochastic matrices, Markov chains
11/8: Intro to statistics, central limit theorem
11/13: Monte-Carlo integration, pseudorandom numbers
11/15: Monte-Carlo simulation
11/20: Binomial and Poisson distributions
11/27: Recurrence relations and generating functions
11/29: Logistic maps and predator-prey models
12/4: Logistic functions and Lotka-Volterra models
12/6: Conservation laws and fluid mechanics