Math 232
syllabus
Spring 2015

Professor:	Matthew Neal (`nealm@denison.edu`)
Office and phone:	Olin 202 (6288)
Office Hours:	MTWRF 1:30-3:30 or by appointment
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Course

This course is an introduction to the mathematical methods used in modeling and analyzing real world problems. The focus of the course is on analyzing (often poorly posed) word problems and communicating conclusions. To do this, you will apply many concepts from Math 124 and Math 231. We will always emphasize the *process* of problem solving. You will have to make many choices about the mathematical model and algorithm you wish to use and you will have to apply your results to a real world context which is messy and subjective. You will have to write about the limitations of your methods, the theoretical justification for your algorithm, and the way your results change if you make different assumptions. You will have to write an analysis and a conclusion that makes sense in the real world context of the problem and is understandable and persuasive to people with minimal mathematical training.

Mathematica will be used extensively and an emphasis will be placed on an algorithmic approach to problem solving. In particular, we will often simulate or approximate solutions in situations where exact solutions are impossible. We will also learn the mathematical logic and creation of such algorithms.

Book

Mathematical Modeling by Mark Meerschaert 4th edition

Grades and Expectations

The grade will be calculated based on homework, quizzes, and 2 final problems

- 30 % for homework problems done jointly with a partner
- 30 % for homework completed individually
- 10 % for weekly quizzes
- 15 % for comprehensive in class modeling test
- 15 % for final project

Every week I will assign a **group of problems to be completed with a partner**. Your partner will change each week. I will also assign a **take home test each week (to be worked on alone) which is based of material from the previous week**. You will also have a **"theory" quiz each Friday** consisting of 1 short answer question concerning mathematical content of some technique we have learned and applied on the homework. There will be an in class final exam on modeling methods on Wednesday, May 6th from 9-11 am (for the 10:30 section) and Monday, May 11th from 9-11 am (for 8:30 section). Also there will be two "final project" problems I will give 2/3 of the way through the semester that are due during finals week.

On the take home assignments there will be a hand-written cover report for each explaining your process, assumptions, approach, methods, and conclusion. This is in addition to your mathematica files. Each partner must do half of these write-ups. Approximately every other week, instead of turning in a report, half of the pairs will come to my office and explain their process, assumptions, approach, methods, and conclusion orally.

Topics and Schedule

We will cover most problems in the book and periodically add some fun math problems from outside the book. Broadly, we will study optimization models, dynamic models, and probabilistic/statistical models.

Each of these topics will feature both analytic methods and simulation. The specific topics and chronology is as follows:

Week 1 Unconstrained optimization: five step method, sensitivity analysis, model robustness

Week 2 Lagrange multipliers, sensitivity analysis, shadow prices

Week 3 Computational methods for optimization: single and multivariable methods: Random Search, Steepest ascent, Newton's method

Week 4 Linear programming

Week 5 Dynamic models: eigenvalue analysis, discrete time dynamical systems

Week 6 Dynamic models: continuous time dynamical systems

Week 7 Simulation of dynamic models: Euler's method and related techniques

Week 8 Probability models: common distributions, mean, variance

Week 9 Statistical inference: central limit theorem, confidence intervals based on Poisson, normal/t, binomial distributions

Week 10 Statistical inference: Fourier transform and diffusion, hypothesis tests based on Poisson, normal, t, binomial distributions, chi-squared test for distributional assumptions

Week 11 Stochastic models: Markov chains, Markov processes

Week 12 Linear regression, time series, application to optimization and dynamical sub models

Week 13 Simulation of probability models: Monti Carlo simulation, simulation with the Markov property, splines

Week 14 non-parametric methods, sports modeling

Office Hours

Every afternoon from 1:30 to 3:30 I will be in my office for help with Math or other issues. Please come to office hours so I can get to know you better!

Late Work

Late assignments will receive a 20 % point penalty per day late unless there is a PRIOR written note (such as a note from Whistler) that verifies a VERY strong excuse (such as illness or important sports team events). Late quizzes are not accepted at all without a written excuse as above.

Academic Integrity

The students and faculty of Denison University and the Department of Mathematics and Computer Science are committed to academic integrity and will not tolerate any violation of this principle. Academic honesty, the cornerstone of teaching and learning, lays the foundation for lifelong integrity.

Academic dishonesty is, in most cases, intellectual theft. It includes, but is not limited to, providing or receiving assistance in a manner not authorized by the instructor in the creation of work to be submitted for evaluation. This standard applies to all work ranging from daily homework assignments to major exams. Students must clearly cite any sources consulted, not only for quoted phrases but also for ideas and information that are not common knowledge. Neither ignorance nor carelessness is an acceptable defense in cases of plagiarism. It is the students responsibility to follow the appropriate format for citations.

Proposed and developed by Denison students, passed unanimously by DCGA and Denisons faculty, the Code of Academic Integrity requires that instructors notify the Associate Provost of cases of academic dishonesty, and it requires that cases be heard by the Academic Integrity Board. Further, the code makes students responsible for promoting a culture of integrity on campus and acting in instances in which integrity is violated.

For further information about the Code of Academic Integrity see http://www.denison.edu/about/integrity.html

Disabilities

Any student who feels he or she may need an accommodation based on the impact of a disability should contact me privately as soon as possible to discuss his or her specific needs. I rely on the Academic Support and Enrichment Center in 102 Doane to verify the need for reasonable accommodations based on documentation on file in that office.