

Course Outline

Math 518 - Mathematical Modeling and Applications

Spring 2006

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Office Hours: Tuesday & Thursday 4-5 PM.

Text: *Towing Icebergs, Falling Dominoes, and Other Adventures in Applied Mathematics*, Robert B. Banks

Software: Maple, Microsoft Power Point, Excel

On December 26, 2004, an earthquake measuring at least 9.0 on the Richter scale struck a region south of Nicobar Island deep in the Indian Ocean. A few hours later, a series of *tsunamis* pummeled parts of Indonesia, Thailand, Sri Lanka, and India, leaving more than 160,000 dead. Yet, if you happened to be in a boat out on the Indian Ocean near the epicenter of the quake, it is unlikely you would have noticed a thing. How could such a destructive wave leave the deep ocean essentially undisturbed? In light of this, how could we hope to construct an early warning system? The art of mathematical modeling holds the key. In this course you'll learn to recognize situations where mathematical modeling can yield answers to important and just plain interesting questions. You'll build, analyze, interpret, and refine these models as we explore such questions as:

- How can we design a tsunami early-warning system?
- Can icebergs supply the world's fresh water?
- What percentage of those who have lived are alive today?
- Could a monkey rank the BCS teams more fairly than a sportswriter?

While at times we will bring university level mathematics to bear on the problems we study, we will also always attempt to see how elementary K-12 level mathematical tools can be applied to our problems. By doing so, we'll strengthen your ability to meet the National Council of Mathematics Teachers Standards – in particular, the standards relating to representation: *Use representations to model and interpret physical, social, and mathematical phenomena*. As we go through the semester hopefully you will see how the examples we discuss can be used in your future classrooms.

Developing mathematical models and examples of such appropriate for use in the K-12 curriculum is a central part of this course. Each of you will be developing a mathematics-based project appropriate for use by a 9th – 12th grader in a science fair.

If you choose to take this class and develop your skills in mathematical modeling you will need to:

- *Read regularly and critically* - Selections from your text and handouts including newspaper articles, magazine articles, and articles from scientific journals will be an integral part of this course. You'll need to read them on time and learn to ask questions of what you are reading. Together, we'll integrate the answers you find with the mathematical tools you already possess as we seek answers to questions like those listed above.
- *Work in a group* - Everyone in the class will be assigned to a permanent 3-4 member team. Your work with your team will be an essential part of the course. Teams will discuss readings, brainstorm ideas, critique each others work, and present group findings. Discussing science and testing your ideas against others is an important part of how science is done, your teammates will help you do this.
- *Present and Participate* - Class discussions will guide our inquiries; everyone in the class has something to contribute and shouldn't hesitate to contribute it! In addition, you will need to present your science fair project to the class.
- *Attend Class* - If you choose to take this class, you'll need to attend. Every class meeting will be designed to help you develop your mathematical modeling skills. Class meetings might involve lecture, group work, class discussion, or even field trips. All are essential. Don't decide to take this class without committing yourself to attending each and every class.

Tentative Schedule:

Exam dates are firm. Lecture dates and topics will be adjusted as needed.

Week	Key events & topics
Feb 7	Course overview, introduction to scaling, dimensional analysis, method of least squares, Fermi problems. First proposal due on 2/9. Read Chapters 1 & 11.
Feb 14	How many people have ever lived? Growth and decay problems. Second proposal due on 2/16. Read Chapters 2, 3, 15, & 16.
Feb 21	Falling objects. Read Chapter 4 & 5.
Feb 28	More falling objects. Read Chapters 17 & 18. Exam #1 on 3/2.
Mar 7	Yet more falling objects. Read Chapters 19 & 20.
Mar 14	Probabilistic & statistical models. Read Chapters 8 & 9. First draft of project report due on 3/16.
Mar 21	Football and needles. Read Chapter 10.
Mar 28	Spring Break
Apr 4	The shape of things. Read Chapters 13 & 14.
Apr 11	More on shapes. Exam #2 on 4/13.
Apr 18	Tsunamis and dominoes. Read Chapters 21 & 22.
Apr 25	More nice shapes, pursuit curves and mountains. Final project report due on 4/27.
May 2	The size of things. (Blimps and such)
May 9	Presentations.
May 16	Presentations.

Assessment: Your final grade will depend on each of the components in the course. In particular,

Homework/Problem Sets	30%
In-class exams (2 X 10%)	20%
Final Exam	15% (or 0% see below)
Presentation	10%
Science Fair Project	25% (or 40% see below)

Homework Policy: There will be several homework sets handed out during the course of the semester. The due date for each homework assignment is firm; no late homework will be accepted. You should write your answers clearly. If I cannot understand an answer, it is wrong.

Science Fair Project: As mentioned above, each of you will be required to prepare a math based science fair project appropriate for a high school student. This consists of several steps:

1. A preliminary project idea. (Due 2/9 – 5/100 points)
2. A revised project proposal. (Due 2/16 – 10/100 points)
3. A first draft of your project report. (Due 3/16 – 35/100 points)
4. A final version of your project report. (Due 4/27 – 50/100 points)
5. An in-class presentation on your project. (Last two weeks of class.)

In addition, you will have the opportunity to work directly with high school students at the Charter School of Wilmington or at other schools you may contact. If you choose to participate in this manner, you will not have to take the final exam. Your project will count for 40% of your grade. However, in addition to your final report, you must also provide me with a web page documenting your project. This will be due the date of your final presentation.