Course Outline
Math 512 - Contemporary Applications of Mathematics
Fall 2005

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Course Web Pages: www.math.udel.edu/~pelesko, www.math.udel.edu/~rossi/math512
Office Hours: Monday, Wednesday, Friday, 3:30-4:30 (Held in my office or in the MEC Lab)
Software: Maple, Microsoft Power Point, Excel, Matlab, Latex

In January of 1995, the Larsen A Ice Shelf in Antarctica disintegrated in a span of only a few days. In 2002, the Larsen B Ice Shelf collapsed over a period of five weeks. The Larsen B Ice Shelf was approximately 3370 km^2 in area. This is about ½ the size of Delaware! How do scientists understand and explain such a catastrophic collapse? The art of mathematical modeling holds the key. In this course you'll develop your skills as a mathematical modeler by working with a team on one open-ended problem for the entire semester. You'll build, analyze, interpret, and refine mathematical models of your system and explore such questions as:

- Why is an ice shelf collapse like domino's toppling?
- How does the speed of collapse of a domino chain depend on the spacing between dominoes? the size? the orientation?
- How quickly does an object fall through a fluid? What happens when the fluid is *non-Newtonian*?

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

- *Read regularly and critically* - The first step in your investigation will be to perform a thorough literature search. This will entail reading numerous articles from scientific journals. You will need to read, understand, and critique journal articles. Often, the work of others, presented in these articles, will form the starting point for your research.
- *Work in a group* - Everyone in the class will be assigned to a permanent 3-4 member team. Each team will work on one project throughout the entire semester. Teams will conduct experiments

together, deliver oral reports on team progress, compile a written project report, and compete against other teams in the class. The bulk of your grade in this course will be related to the success of your team.

- *Present and Participate* - Class discussions will guide our inquiries, everyone in the class has something to contribute and shouldn't hesitate to contribute it! Teams will need to present their findings and give progress reports on a regular basis. This might mean a quick oral presentation or a more polished Power Point presentation. You are expected to question and critique the work of your classmates.
- *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.
- *Use Resources* - Numerous resources are available to students in this class. You should use the MEC Lab and its capabilities for your experiments. You should discuss your project with your classmates. You should take advantage of the library, both online and hardcopy. You should also make sure you have your calculus, differential equations, linear algebra, and physics textbooks handy.

Course Structure: Class time in Math 512 is designed to support student project teams in their investigations. Normal class time will consist of the activities below. Activities to be completed outside the classroom are also outlined.

- **Mini-lectures** - Throughout the semester I will lecture on topics that are relevant to the projects. You should feel free to request lectures on topics that you discover you need and yet feel uncomfortable with. Students should be aware that there is no sense in which I will solve any aspect of any project during a mini-lecture.
- **Problem Sets** - There will be a few problem sets and mini-projects designed to reinforce the material in the mini-lectures and help you gain experience using tools and techniques necessary for your project.
- **Presentations** - Starting in the fourth week, Mondays will be reserved for team updates. One speaker from each team will be selected by me. All students will be expected to comment, criticize, and question all

presentations. Note that you will be graded on your presentations and on your participation in the discussion.

- **Weekly Planning Report** - At the start of each class where presentations are to be held, each team must turn in a weekly planning report. The report should be a typed, itemized list and the presentations should reference the material in the weekly planning report. Reports should be *specific*. "This week we are going to perform three experiments in the MEC Lab. These are…" is appropriate. "This week we are going to try an experiment" is not.
- **Laboratory Notebook** - Each team must maintain a laboratory notebook for their project. Periodically, I will collect and examine your notebooks. The notebooks should document all activities related to your projects. Everything in your final report should come from your notebook. I suggest assigning one team member to take primary responsibility for the notebook.

Tentative Schedule:
Milestone and competition dates are firm. Lecture dates and topics will be adjusted as needed.

Week	Key events & topics
Aug 31	Introduction, project presentations, MEC Lab tour
September 7	Tools of the trade, group mini-project
September 12	Milestone #1, group discussion, intro to dimensional analysis
September 19	Refresher on ODE's, intro to the phase plane, scaling
September 26	Intro to PDE's, basic continuum mechanics
October 3	Milestone #2, Competition #1
October 10	Working with data
October 17	Solution methods for PDE's
October 24	Milestone #3, Competition #2
October 31	Numerical methods for differential equations
November 7	Variational methods
November 14	Milestone #4, Competition #4
November 21	More variational methods
November 28	Miscellany
December 5	Milestone #5, Competition #5

Project Milestones: The milestone structure is intended to help teams make organized progress toward their goals. Each milestone marks a different stage in your progression toward a final project that will be the culmination of the course. Each milestone consists of two parts. Part one is a written report outlining the problem and the team's progress and prospects. Part two is a competition with teams working on the same project as your team. Grades will be assigned differently for different milestones. Your written report will be graded based on the breakdown below. Competitive results will translate into grades for the second part of each milestone. The competitions will be outlined individually for each specific project.

Milestone	Lit Review Assumptions Definitions Formulation	Analysis Solutions Measurements Parameter Estimation	Simulations Comparison Strengths & weaknesses Synthesis	Lab notes Style Clarity Presentation
1	80%	5%	0%	15%
2	20%	60%	0%	20%
3	5%	40%	25%	30%
4	0%	40%	20%	40%
5	0%	20%	30%	50%

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

Milestones 1-5 (including competitions)	75% (15% each)
Homework/Problem Sets	10%
In-class presentations	7%
Weekly planning report	4%
Participation	4%

Students taking the course as an honors course will be expected to complete work equivalent to an additional milestone. Their grade will depend on this additional milestone as well as the above.

Honors Component: Students taking Math 512 as an honors course will need to complete two tasks in addition to the normal tasks of the course. They are:

- Write a section of the final report entitled "Future Work Plan." This will a research program intended to carry the work completed by their

team into the future. The plan should survey the literature, what the team has done, and outline a detailed plan that attacks open questions.

- Prepare a poster on their team's project. The poster will be due on the date scheduled for the course's final exam. The poster should be delivered both in electronic format and hardcopy. The large printers in Smith may be used for this task. A printout costs approximately $12. Example posters may be found in the MEC Lab. Students should consult with the instructor regarding their poster prior to printing.