Department of Applied Mathematics and Statistics
COLORADO SCHOOL OF MINES
MATH484: Capstone - Mathematical and Computational Modeling

Final Project Guidelines and Topics
Due Dates: March 5; April 7; May 1

For the final project, each individual student or team of (two or three) students will write a report on a specific application of the mathematical topics we've discussed throughout the semester pertaining to a problem in the applied or natural sciences. A final presentation to the class that highlights the main points of this report will also be required and presented either by the individual student or collectively by the team of students, with each member participating fully. Though you are welcome to work within teams, I strongly suggest that those students who plan to enroll in our B.S./M.S. program use this project as an opportunity to discuss research with prospective advisors and begin preliminary work on their thesis.

Content and Grading

Since this is an applied mathematics course, mathematical content should occupy a central role in the paper, and a careful explanation of the mathematics involved is critical. Your work will be graded on mathematical accuracy and content, explanation of the problem, computational fluency, organization, style (spelling, grammar, etc.), overall effectiveness, and adherence to guidelines. In particular, all final reports must satisfy these requirements:

1. The report must include a section describing the background and formulation of the physical, chemical, biological, or engineering problem modeled by a system of differential equations (no more than 2 pages). For example, it should contain a clear explanation of the problem, its importance, and some of its history.

2. The report must include a section describing the mathematical analysis of the problem. This may include information gained by analyzing the model using theorems from Calculus or Analysis, an analytic representation of solutions in special cases, a discussion of parameter values, or a summary of any known mathematical results for the model.

3. The report must include a section implementing computational approximations of the model using MATLAB. Upon running simulations and including plots, suitable descriptions of the associated behavior of the model should also be included. Additionally, this section should contain remarks regarding the properties of computational approximations (e..g, stability, accuracy, efficiency) if appropriate.

4. The report must use the information in the previous section to draw non-mathematical conclusions. You should analyze your mathematical and computational results and interpret them within the context of the problem. For example, if you are modeling the level of a drug in the bloodstream, the mathematical results should tell you something about what happens to the concentration over long periods of time or how you expect the drug levels to fluctuate. You should also discuss other questions raised by your investigations.

5. The paper must include a suitable bibliography with appropriate citations.

Possible Topics

Below are some possible project topics. These are merely suggestions and you are certainly encouraged to think of topics for your own final report and presentation, or work with a prospective M.S. thesis advisor on an additional topic.

- Mathematical Epidemiology (SIRS, SIES, MSIR, and other models)
- Models of Climate Change (glacier and ice sheet dynamics, carbon levels)
- Fluid dynamics (e.g., one-dimensional two-phase flow)
- Materials (homogenization, segregation in alloys, etc...)
- Pattern Formation (in rivers, dunes, flora, lasers, etc...)
- In-host population models of disease (HIV, Hepatitis, Tuberculosis, etc...)
- Wave Propagation (acoustics, electromagnetics, etc..)
- Models of Tumor Growth & Chemotherapy (e.g., Kuznetsov equations)
- Models of Physiology (blood flow, cardiovascular dynamics, cell migration)
- Models in Neuroscience (Hodgkin-Huxley, Fitzhugh-Nagumo, etc...)
- Chemical Reactions (enzyme kinetics, glycolysis, autocatalators, etc...)
- Genetics and Gene Expression (Fisher's equation, mRNA, etc...)

Deliverables

The required deliverables are a proposal, progress report, presentation, and the final project report. All documents should be typed and presented as polished, final work. Keep in mind that a portion of the grading will be based on the clarity of your presentation and the thoroughness with which you address the problem.

1. Project Proposal (**Due March 5**)
   Submit a one-page paper that outlines your intended goals for your final project. Provide a brief background of the process or system that you will model and outline the work you intend to perform. Stating specific goals as an ordered list is highly suggested as this will provide you with a framework to follow as you develop, analyze, and simulate your model. The proposal will be graded on feasibility and writing - resubmissions and corrections will be allowed.

2. Progress Report (**Due April 7**)
   Submit a one-page paper that highlights the goals you have accomplished to date and outlines the remaining goals that you intend to finish. This must include at least one simulation and a prominent completed goal.

3. Final Presentation (**April 23, 28, and 30 in class**)
   Present your final project results. Current undergraduate and graduate students and faculty members will be welcome to attend, make comments, and ask questions.

4. Final Project Report (**Due May 1 at 5:00pm in SH 223**)
   Submit your final report. The expected length of the paper for an individual project is around 10 pages (around 15 pages for a group project). The report should clearly describe the problem, provide background, and present results and conclusions in a readable, organized manner.