Math 462:
Mathematical Modeling

MWF 11:00-12:00, 1300 Chemistry

http://www.math.lsa.umich.edu/courses/462/

Instructor: Dr. Patrick Nelson

Course Synopsis:

This course is designed to provide upper level undergraduates and beginning graduate students with an understanding of how mathematical modeling is the link between mathematics and the rest of the world. Nature is highly complex and mathematical modeling can help to unlock the secrets to problems in Engineering, Physics, Astronomy, Biology, Medicine, and Chemistry to just name a few. Modeling is a way of structuring questions about Nature which then allows mathematical techniques to be used to solve it. However, this is not the end of the story. One must then reverse the process to be able to explain the answer in terms of non-mathematical language. Besides an introduction to Dynamical Systems and Probability, this course will focus on modeling techniques such as sensitivity, selection, and identiability. All of these topics are crucial to validate the models being used. Unlike many modeling courses that use a textbook that focuses on one kind of mathematical model, this course will cover a broad spectrum of modeling problems, from optimization to dynamical systems to stochastic proceses.

Part of the course will use the textbook by Mark Meerschaert, called Mathematical modeling. Most mathematical models fall into one of three categories: optimization models, dynamical system models, and probability models. The course will be divided into three main parts: Optimization models that will cover topics such as sensitivity analysis, model robustness, model identifiability, multivarible optimization and linear programming. The second part will focus on Dynamical Systems that will cover both the analysis, including bifurcation theory, and computation. Finally, we will spend time covering probability models, both discrete and continuous and stochastic models.

Students will spend time working in a computer lab using matlab to visualize the results that are found via pen and paper. If time permits, we will also cover some topics in Calculus of Variations. There will time set aside for group discussions and modeling projects related to the more interesting and advanced issues concerning topics of interest. Approximately one class period each week will be held in the mathematics computer laboratory where numerical techniques for finding and visualizing solutions of differential and discrete systems will be discussed.

Text:

This course will follow closely several chapters of: *Mathematical Modeling*, Mark M. Meerschaert, 2007 supplemented by material from the current literature and lecture notes from the instructor.

Prerequisites:

In order to be successful in this course, it will be necessary to have completed the following mathematics courses or their equivalent: Math 217, 417, or 419 and Math 216, 286 or 316 or to have permission of the instructor. Introduction to Dynamical Systems would be helpful.

Grading:

Grades will be based on the completion of a final project which will be based on a substantial research paper (25%), two quizzes (50%), and weekly (or biweekly) homework assignments and in class presentation of problems (25%). Note: There will also be numerical component to some of the homework assignments which will require the use of MATLAB or MAPLE. **Also, this course will have a students with a variety of backgrounds, hence the substance of the research project will be based on your groups level and not compared with other groups.**

- Homework policy
  NO LATE homework will be accepted unless permission is given ahead of time. All homework will be due at the BEGINNING of class.

Office Hours and Location:

I will be available outside of class time to assist with homework and project preparation during the following times or by appointment:

Wednesday 10:00 - 11:00 and Thursdays 2:00-3:00 pm

My office is located in East Hall #5860. To schedule an appointment please call 763-3408 or send an email to pwn@math.lsa.umich.edu.

Schedule

(**DISCLAIMER:** This is a *ROUGH* schedule. I reserve the right to modify this as needed.)

WEEK	MON.	TOPIC	WED.	TOPIC	FRI.	TOPIC
1					**Jan. 4**	Introduction
2	**Jan. 7**	Modeling Overview	**Jan. 9**	Dynamical Systems	**Jan. 11**	Lab 1
3	**Jan. 14**	Optimization	**Jan. 16**	Optimization	**Jan. 18**	**Lab 2**
4	**Jan. 21**	Holiday	**Jan.. 23**	Sensitivity	**Jan. 25**	Lab 3
5	**Jan. 28**	Sensitivity	**Jan. 30**	Sensitivity	**Feb. 1**	**Lab 3**
6	**Feb. 4**	Identifiability	**Feb. 6**	Identifiability	**Feb. 8**	Lab 4
7	**Feb. 11**	Selection	**Feb. 13**	Selection	**Feb. 15**	Quiz 1
8	**Feb. 18**	TBD	**Feb. 20**	TBD	**Feb. 22**	Lab 4
9	**Feb. 25**	Spring Break	**Feb. 27**	Spring Break	**Feb. 29**	Spring Break
10	**Mar. 3**	Dynamical Systems	**Mar. 5**	Dynamical Systems	**Mar. 7**	Lab 5
11	**Mar. 10**	Bifurcation Theory	**Mar. 12**	Bifurcation Theory	**Mar. 14**	Lab 5
12	**Mar. 17**	Probability	**Mar. 19**	Probability	**Mar. 21**	Quiz 2
13	**Mar. 24**	Probability models	**Mar. 26**	Probability models	**Mar. 28**	Lab 6
14	**Mar. 31**	Stochastic models	**Apr. 2**	Stochastic models	**Apr. 4**	Stochastic models
15	**Apr. 7**	TBD	**Apr. 9**	TBD	**Apr. 11**	TBD
15	**Apr. 14**	TBD	**Apr. 16**	Classes End	**Apr. 18**	

FINAL EXAM : Due Wednesday, April 22 by 12:00pm.