MATHEMATICS 454
Ordinary Differential Equations and Stability Theory

MWF 2:00-2:50, PAS 414

"A very small cause which escapes our notice determines a considerable effect that we cannot fail to see, and then we say that the effect is due to chance. If we knew exactly the laws of nature and the situation of the universe at the initial moment, we could predict exactly the situation of the same universe at a succeeding moment. But even if it were the case that the natural laws had no longer any secret for us, we could still know the situation approximately. If that enabled us to predict the succeeding situation with the same approximation, that is all we require, and we should say that the phenomenon had been predicted, that it is governed by the laws. But is not always so; it may happen that small differences in the initial conditions produce very great ones in the final phenomena. A small error in the former will produce an enormous error in the latter. Prediction becomes impossible."

–Henri Poincaré

Text:

- Strogatz: *Nonlinear Dynamics and Chaos*

Instructor:

- Dr. Karl Glasner
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- Office Hours: MWF 10:00-11:00, and by appointment
- Web: http://www.math.arizona.edu/∼kglasner/math454/math454.html

Course Description:

This course is an outgrowth of the study of ordinary differential equations, and would more typically be called "Dynamical Systems". Rather than focusing on the question "what IS the solution" (which is, in most problems, impossible to fully address), we ask "what properties do solutions possess"? The study of dynamical systems is therefore meant to address both qualitative and quantitative features rather than solution techniques (although some will be needed to make things concrete). The end of this course is an introduction to some of the most significant (and well publicized!) developments in quantitative science that have occurred over the last half century. We will encounter and make precise familiar buzzwords such as "chaos" and "fractal". Along the way, some advanced ideas in applied mathematics will be carefully introduced.

Grading Policy:

Grades are based upon quizzes (derived from suggested homework, see the web site), and projects that may involve computer work. The lowest quiz grade will be dropped. If a quiz is missed, this will automatically count as the dropped quiz. The course grade will be determined by combining performance on each as follows:

50% quizzes
50% projects

Grades will be assigned roughly as 90-100=A, 80-89=B, etc., with some possible adjustment downward being made as the semester progresses. The final grading scale will not reflect a "curve" that is sensitive to the class average, but is rather based upon some fixed benchmark of knowledge acquisition.

Quizzes:

Every 3-4 lecture periods, a quiz will be given concerning material covered since the previous quiz. The quiz questions will be **heavily** based on suggested homework problems listed on the web site, so doing these ahead of time will significantly enhance your performance.

Projects:

There will be several computer related projects assigned and posted on the web-site. These are meant to give you more of a hands-on experience with the subjects. Some of the projects require the use of MATLAB, a high-level mathematical environment and language. If you are unfamiliar with this program, a tutorial is available on the web-site. Additionally, the first project gets you used to this program. You will generally be given templates for MATLAB projects, so very little coding on your part will be needed. Projects **MUST** follow the rules of writing and presentation detailed below.

Attendance:

Students should be familiar with the university attendance policy. Attendance in EVERY class is mandatory. As few as three (3) unexcused absences will result in either an administrative withdrawal, OR automatic failure of the class, at the discretion of the instructor.

Calendar:

Week of Jan 10: Introduction, Chapter 2
Week of Jan 17: Chapter 2 (No class Monday)
Week of Jan 24: Chapter 3
Week of Jan 31: Chapter 3,4
Week of Feb 7: Chapter 4
Week of Feb 14: Chapter 5,6
Week of Feb 21: Chapter 6
Week of Feb 28: Chapter 6,7
Week of March 7: Chapter 7
Week of March 21: Chapter 8
Week of March 28: Chapter 8, 10
Week of April 4: Chapter 10
Week of April 11: Chapter 9, 11
Week of April 18: Chapter 11
Week of April 25: Chapter 11,12
Week of May 2: Chapter 12

Written project requirements

NOTE: It will be a general policy that work which does not follow these guidelines will be returned without a grade.

Presenting mathematical ideas should be no different than any other subject. The usual rules of good writing should apply, especially neatness, clarity and organization. Good examples of mathematical writing can be found in many (but by no means all!) textbooks. This is the style you should emulate for written assignments in any advanced course.

Some specific considerations are:

(1) The most important rule: brevity. Answers should be as long as necessary to convey all significant details, and NO LONGER!

(2) Complete, grammatically correct sentences (yes, just like in other classes) are essential. Note that equations are **parts** of sentences and should be accompanied by text and proper punctuation.

(3) Organizing ideas is the most important part of writing. Large problems or projects may require organization into paragraphs and even entire labelled sections. **Sections in the project write-up must correspond to the sections of the project description.**

(4) Projects in 454 must be typeset or word processed. Equations are ideally typeset (using LaTeX, equation editor, etc.) or can be neatly handwritten into the narrative. Note that not every detail of a mathematical calculation is necessary - selecting which equations to display is a bit of an art.

(5) Graphs should be annotated (by hand if necessary), and a textual explanation should accompany. In the case where computer code is used, a copy of the code and graphical/ numerical results should be included at the end. If many variations of the same code is used, only a basic template in necessary.