1 Class Projects

An important part of the course will be your class project. My preference is for two people to work jointly on a project, but one or three person teams are ok also.

1.1 Tentative Schedule

1. By October 1, send me an email with (a) your team members, and (b) a tentative project topic. A list of possibilities appears below, and your task between now and Oct. 1 is to look at some of these in more detail and see what interests you. To avoid confusion, each team member should send me a separate email confirming the team and the tentative topic.

2. Between Oct. 1 and Oct. 8 each team should meet with me to discuss the project and how best to proceed. In some cases I may conclude that this particular project is not suitable and suggest something related but not exactly the same. 10% of the total project grade will be based on this meeting. (I just want to make sure you have spent some time and effort deciding what to do. For example, I might ask which sources you have looked at in making your choice. I’m not going to mark you down simply because I think another project might be better for your team.) I won’t rule out a project just because someone else chose the same thing, though I might try to steer different teams towards different aspects of the problem.

3. I will meet with each team around Nov. 1, and again around Nov. 15 to hear your progress and discuss what to do next. We can discuss questions you may have about the problem you are working on.

4. A written report is due by midnight on Nov. 25, the Tuesday of Thanksgiving week. I may return it on Monday, Dec. 1 for slight revision, in which case the final document is due on Friday, Dec. 5 (the last day of classes.)
5. Each team will also meet with me to discuss the project. If your project is basically a proof taken from another source, then during this meeting I might ask your group to explain some of the steps in the proof. These meetings should be for around 15 minutes. Each team will also give a ten minute in-class presentation of what they did, during the last week of classes. I will try to stay quiet, but hope the other students will ask some questions.

1.2 Some technicalities

You are encouraged to use the math typesetting language Latex to produce your document as a .pdf file. However, neat handwriting, or a combination of word-processing and handwritten equations, is also acceptable. Latex is available in the 7th floor math computing lab, but I am not sure how user-friendly the interface is. Learning Latex is a worthwhile time investment, but not required.

As I said in an earlier message, if you want to do a numerical project, you will want to learn the package xppaut, which can be found on Professor Ermentrout’s website. He has also written a book on this program, with many exercises. In fact, it might be possible to develop a project based entirely on examples in this book. I am looking into whether a copy of this can be put on reserve in the library.

1.3 Some ideas for projects

1. Numerical study of the Lorenz equations (chapter 9.8 plus book of Sparrow.)

2. Investigation of weaker conditions for existence or uniqueness. (Below I list several specific papers that would help with this topic)

3. Derivation of the equation for a forced pendulum from principles in physics. I am thinking of a situation in which the pivot point of the pendulum is moved up and down in a periodic fashion, thus affecting the motion of the pendulum. I will give more detail about this in class.

4. Proof that the equation $x' = x^3 - x + \sin t$ has at least three periodic solutions. The first homework was about the equation $x' = x^3 + \sin t$. We will discuss this in class eventually. In this project, a more complicated equation is studied, and you have to work out rigorous proofs, modeled on what is done with the simpler equation.
5. A project based on one of the papers listed below. I think all of them can be
found in the math library, or retrieved from the library’s storage facility. The
math librarian can help with this.

6. Project based on examples and exercises in Prof. Ermentrout’s xppaut book.

Papers to consider. I haven’t looked at many of these. If one sounds
interesting, get hold of a copy and look it over. If you are unsure about
it, bring it to me and I’ll give you my opinion. You are also free to
suggest a project of your own.

- Necessary and sufficient conditions for oscillations

- Some mathematical problems from neurobiology
  SP Hastings - Amer. Math. Monthly, 1975 -

- Optimal velocity in a race
  JB Keller - American Mathematical Monthly, 1974

- Elementary quadratures of ordinary differential equations
  L Hongxiang - Amer Math Monthly, 1982 -

- Reconstructing a function from its set of tangent lines
  A Horwitz - American Mathematical Monthly, 1989

- A new proof of Sturm’s comparison theorems

- The Existence-Uniqueness Theorem for an n-th Order Linear Ordinary Differential Equation
  D Willett - Amer. Math. Monthly, 1968 -

- Cyclic pursuit or ‘The three bugs problem’
  MS Klamkin, DJ Newman - The American Mathematical Monthly, 1971

- A Chaos Lemma
  J Kennedy, S Kocak, JA Yorke - AMERICAN MATHEMATICAL MONTHLY,
  2001
  (This may or may not be about ode’s .)
Large Torsional Oscillations in Suspension Bridges Visited Again: Vertical Forcing Creates Torsional . . .
PJ McKenna, CO Tuama - AMERICAN MATHEMATICAL MONTHLY, 2001

A supplement to the Sturm separation theorem, with applications

On the asymptotic behavior of linear differential equations

Blowing up singularities in classical mechanical systems
RL Devaney - Amer. Math. Monthly, 1982 -

Uniqueness theorems for ordinary differential equations
AD Ziebur - Amer. Math. Monthly, 1962 -

Asymptotic Behaviour of Nonlinear Systems
H Logemann, EP Ryan - AMERICAN MATHEMATICAL MONTHLY, 2004

On Elementary Proofs of Peano’s Existence Theorems
J Walter - American Mathematical Monthly, 1973

Topology of the two-body problem
W Kaplan - American Mathematical Monthly, 1942 -

Some consequences of the Sturm comparison theorem

When is an Ordinary Differential Equation Separable?
D Scott - American Mathematical Monthly, 1985 -

The robot and the rabbit—a pursuit problem
B Halpern - American Mathematical Monthly, 1969 -

The Nonlinear Simple Pendulum
F Brauer - American Mathematical Monthly, 1972

Two-Point Boundary Problems
RH Cole - American Mathematical Monthly, 1965 -

Anatomy of the ordinary differential equation
WT Reid - Amer. Math. Monthly, 1975

Continuous Dependence of Solutions of Ordinary Differential Equations
A Strauss - American Mathematical Monthly, 1964

Is there an elementary proof of Peano’s existence theorem for first order differential equations
H Kennedy - The American Mathematical Monthly, 1969

Elementary Uniqueness Theorems for Differential Equations
DA Kearns - American Mathematical Monthly, 1961

Differential Equations for Flow of a Solution of Varying Concentration
JC Burns - American Mathematical Monthly, 1968