Math 254: Ordinary Differential Equations

Project Instructions

The goal of the project is to study an application of differential equations.

You are expected to submit five to ten type-written pages, that fully analyze an application / model of your choice. You are required to turn in the project both printed and in an electronic form (PDF or word file), and in font size 12. You are expected to add a bibliography of all the sources you used. The topic of the project should be approved by the instructor, and you should work on the project in pairs.

You are more than encouraged to discuss your work and thought processes with your classmates. However, be aware that your project will be checked for plagiarism.

The project is due on **Friday August 5**, and a draft is expected by **Friday July 29**. The draft is worth 20% of the final project score. In case you need to use material that still hasn't been covered in class in your draft, you may omit it, but remember to include it in your final paper. In addition, you are expected to submit a printed outline of your project. The outline should include the equation(s) you choose to study and a list of questions you are hoping to answer in your project. The outline is due on **Friday July 22**, and will be graded as a homework assignment.

Below you'll find a description of a general scheme for approaching a new model. You do not need to follow the instructions below on a step-by-step manner, but you should make sure to include each one of the steps listed below in your project. Students who address each of the steps listed below in their project in a satisfactory manner should expect a full score for the project. That being said, the difficulty of the problem you choose will be taken into consideration in the grading process, and you may not be able to fully answer all of the steps below in some circumstances (if so, please consult the instructor to make sure it is OK to omit them).

A crucial part of this project is the interpretation of your solutions. Please explain as clearly as you can and be sure to use complete and coherent sentences. Good mathematics is not just about symbolic manipulations, it is also about communication skills which will help you to better understand the mathematical ideas. The project will be graded accordingly.

1. State your application, and explain why it is of interest.
2. Write the ODE that models the application you choose to cover. In case there is more than one ODE that models your application, consult the instructor. You may want to study more than one equation.

   Make sure to explain the physical meaning of each of the quantities that appear in the equation(s). If you can, try to include a derivation (or at least an intuitive explanation) of the equation(s) and why the equation(s) can indeed model the problem.
3. Classify the equation. What order is it? What kind of an equation is it? (linear, separable, exact, etc...)
4. Can any of the uniqueness / existence theorems we studied be applied to the equation? Under what conditions does the equation(s) have a unique solution? Explain and include any theorem you may use and its conditions.
5. Provide a qualitative study of the equation. Does your equation have fixed point solutions? Will they be stable / unstable? What will be the long term behavior of the solutions?
6. Solve the equation: if you can solve the equation analytically in the general case - great. If this is not the case, find a series solution and/or a numerical solution.
7. Visualize the equation and its graphs. This may include graphs of the solutions, the direction flows, the physical model you study or any other graphs/diagram that might explain the application. Make sure that each graph contains axis labels. Recall that a picture is worth a thousand words, but don't forget to use words to explain the pictures you add.
8. What is the meaning of the solutions? Analyze and explain what the solutions tell you about the problem. Compare the model and its implications on the physical world - is this a good model? Explain.
9. What are your conclusions about your application?

You are strongly encouraged to consult the instructor while working on the project.

Good luck!