

Differential Equations Course Project

In this course, you are being asked to complete a course project (in small groups). This handout details the information you need to complete the project successfully. The project is worth 20% of your final course grade. Please plan your time and effort accordingly.

Project Goals: The learning goals of the course project are to have you extend your knowledge of differential equations according to your own personal interest, to demonstrate your new ODE skills and enhance both your technical writing and communication skills.

Project Description: You have two basic options in your project.

OPTION 1: Choose a topic in differential equations from one that we will not cover in our class such as:

- Using differential equations in biological systems (modified predator-prey, HIV or SIR models, etc)
- Series solutions of differential equations
- Solution methods for special types of equations (Bernoulli Equations, Exact equations, Cauchy-Euler equations, etc)
- Analyzing resonance of (overdamped, underdamped) systems of linear 2nd order ODEs with forcing terms
- Higher-order numerical methods for solving ODEs (i.e. Runge-Kutta, Modified Euler, Heun's Method etc)
- Boundary value problems (as opposed to initial value problems) and their applications
- Difference Equations
- Chaos and strange attractors (i.e. the Butterfly effect, Lorenz equations, etc)
- More complicated examples of bifurcations (i.e. Andronov-Hopf bifurcation, etc)
- Definition of special functions that involve ODEs (Bessel's functions, Legendre functions, Laguerre functions, hypergeometric functions, elliptical functions, Jacobi functions, etc)
- The Matrix Exponential
- Analysis and classifications of equilibrium points of 3-D linear systems
- Other integral transforms (other than Laplace transforms)
- Proof of the Existence and uniqueness Theorem, Poincare-Bendixson Theorem, etc
- Other mathematical models of physical or real-world phenomena

OPTION 2: Choose an application of differential equations that show up in another field or discipline and discuss what concepts from the class are used in order to understand or explain that context. The project may be done as a trio or pairs (or in very rare cases as an individual) but in all cases groups get a single grade assigned to them, with members and myself having input into how the credit should be allotted.

Project Timeline: Your project will have several deadlines associated with it. Although the majority of your project grade will be based on the final paper and presentation, failure to fully complete a step by the deadline will result in at least a 5 point deduction off that component. The project is worth a total of 300 points

1. **Project Proposal: Friday, October 2nd.** [50 points] On this day you will turn in a project proposal that is no less than one page typed and double spaced. It should explain whether you are choosing option 1 or option 2, your project topic and how the topic is connected to differential equations. It should include any references you already have that you plan to be using. If you are choosing option 1, please attach one copy of your primary paper (you can consult many papers, but only attach the “main” one) as well as an idea of references you may still need to find. It should also include a detailed plan to complete your project and what you want your punchline to be that is, you should have an understanding of why your project is cool and important. If you are proposing a group project, you should also detail how each member plans to contribute. You only need to include one copy of the proposal, signed by all members.
2. **Rough Draft: Friday, November 13th:** [50 points] One component of your final project will include a formal write up of your work. You should turn in a rough draft of your project paper by Friday, November 14th at 5 p.m. It is fine to turn in your rough draft early. Drafts should be submitted by hard copy and not electronically. The length of the paper will vary between projects, but it is anticipated that no project will be adequately described in less than 5 pages. You should also include an outline of the paper with your rough draft. This is a technical paper and should include an abstract, an introduction, a paper body, a conclusion, and appendices. Figures and relevant data should be included and properly labeled. You should also make sure to cite any references you have used.
3. **Final Paper: Wednesday December 3rd:** [100 points] Everyone will turn in their final paper on Wednesday December 2nd by 5 p.m. Notice that this date is the very last day of class.
4. **Oral Presentations: Monday November 23rd , Monday November 30th and Wednesday December 2nd.** [100 points] Oral presentations will be done in class. Because of the large size of the class this will probably take three full class days. Each project group should plan on speaking for 12 minutes if the group consists of two people or 8 minutes if solo and 15 minutes if the group is the trio. This is not a long time to explain the amount of work you have been doing, so your presentations will have to be well prepared and practiced. Your presentation should be done with the use of a computer projector in a medium such as power point. A properly timed presentation will be within a minute of the allotted time. Speaking for a significantly shorter or longer length of time will affect your project grade by at least 5 points.

Project Grade: 300 points total. Worth 20% of the Overall Course Grade.

Project Proposal: 50 Points (**Friday October 2nd**)

Rough Draft: 50 Points. (**Friday November 13th**)

Final Paper: 100 points. (**Wednesday December 2nd**)

Oral Presentation: 100 points. (**On one of the Last Three Days Of Class**)