In this project, you will work with a small group of peers to select an engineering-relevant dynamical system, decide on an appropriate numerical method to solve that dynamical system, and perform systematic studies that let you explore something that excites you about the dynamical system that you've chosen.

Your project grade will be based on an evaluation of a technical report that you submit. Your report should be typeset in Latex, and your submission should be the .pdf output of that document. The grade will be based on the following components. You have freedom in what report structure you choose, but may wish to adopt a report structure that mirrors the evaluation criteria below:

1. (22 points) Present a dynamical system that is relevant to engineering. (i) Describe why that dynamical system is interesting/important to understand, (ii) synthesize a question or set of questions that you want to ask of that dynamical system, and (iii) convey your dynamical system mathematically. Be sure that you specify any parameters that the dynamical system depends on, and which parameter value ranges are relevant to the specific questions you want to explore.

2. (22 points) Present a numerical method that is appropriate to study the questions that you've asked of the dynamical system. Your presentation will be evaluated based on (i) your justification for why the method is appropriate to address the questions you want to probe in your dynamical system, using accuracy, stability, and cost considerations; (ii) your mathematical derivation of the method including its error and stability properties; (iii) an algorithmic summary of how the method advances a solution from some time instance t_k to t_{k+1}.

3. (22 points) Demonstrate correct implementation of the method. This demonstration should include (i) appropriate error convergence studies that shows your method scales at the expected convergence rate; (ii) an evaluation of which simulation parameters (e.g., time step size) your method needs to use so that you can accurately study the problem of interest.

4. (22 points) Present results that meaningfully address the question you ask. The results should utilize professional, concise text along with clear companion figures that get at the heart of the questions you pose in part 1. Be thoughtful about these results! Raw results that plot the trajectory of your state variables as a function of time are rarely the most direct way of addressing the specific questions you posed.

5. (6 points) A summary description of everyone's roles in the project. These summary descriptions should provide a rough estimate of the percentage of the project that each group member contributed. There is flexibility in how the group structure is set up. Everyone can work equally on every part of the project, or you can provide team leads for things like defining the problem statement, picking and justifying the method, coding the method, etc. A few essential elements of the group contribution plan: (i) each student must contribute meaningfully to at least one of the rubric items (1)–(4). That is, it is insufficient to contribute nothing to rubric items (1)–(4), but to try to "offload" this by coordinating everyone on Discord and being responsible for the final group writeup. Those latter elements are important and worth mentioning in the summary descriptions, but are insufficient unto themselves for full credit on the group project. Insufficient demonstration of contribution to at least one of the rubric items (1)–(4) could lead to point deductions from the nominal group grade. (ii) The estimated percentage of the member contribution to the project must be meaningful. It is not essential that everyone's percentages are identical, but noticeable discrepancies in percentages could lead to point deductions from the nominal group grade.

6. (6 points) Reproducibility. You should provide a link to your code that contains the full version of the code, including whatever is needed to run the convergence tests and generate any results that you use in your report. For full credit, the code must be well organized, ideally distinguishing between the code that implements the numerical method (perhaps as a function that time marches the solution), and the other codes that perform convergence tests and generate results. **Code that is hosted as a well-constructed repository on Github can be awarded up to 3 bonus points on the group project grade.**

Remember that Project 1 (the individual and group portions combined) is worth 30% of your semester grade. That is, this group project portion is worth 15% of your semester grade. As such, I am looking for you to go well beyond what is expected from a homework submission, and take ownership of your work on this project. Going "beyond what is expected" will mean different things to different people. I want to build in flexibility for that "above and beyond" component to be driven by something you're passionate about. Just be sure to work hard and have fun!

As always, chatGPT usage is encouraged. It may not be tractable to provide a single chat transcript or set of chat transcripts from your interactions with chatGPT. Instead, please create an Acknowledgments section where you make it clear the role that chatGPT had in your project. The role chatGPT plays should reflect that your group drove the project directions, pushing chatGPT to complete tasks and fact checking what it does!