Background

The Vortex Lattice Method (VLM) is an invscid method for the low-fidelity analysis of lifting bodies (wings). For this assignment, you will be utilizing a Julia package called VortexLattice.jl to explore aspects of wing aerodynamic performance.

Assignment

Start a new branch on your repository. Name it something relevant to the project. Create github issues for at least steps 3-5. You should use these issues to write down questions you have about those steps of the assignment for reference in your weekly meeting with your graduate student mentor. Close each issue you create with a comment as you finish each step.

1. Read through the chapter 4 in the ME EN 515 Text (linked below) and chapter 5 in the ME EN 415 Text (linked below). As you read and come across unfamiliar terms (see hint below), look them up and include them in an appendix in your report. As part of the definitions, include images and equations to add clarity where applicable.
   - You may consider, rather than including an appendix in your papers, producing a dictionary of terms for yourself using the wiki feature on github.
2. Complete the Getting Started and 3 Steady State Examples in the VortexLattice.jl documentation Take notes on which functions you'll need for the rest of the assignment and how to use them (i.e. write some pseudo code).
   – Note that you can simply use the geometry in these examples for several parts of this assignment.
3. Explore and discuss the effects of wing lift distribution vs wing efficiency. There are several ways to accomplish this, but here's one way you might start:
   (a) Write a function that takes in the root chord and span of a wing as well as a number of sections used to define the wing.
   (b) Have the function use the root chord and span numbers to define an ellipse.
   (c) Use the number of sections to divide up the wing span.
   (d) Have the function return the values of the leading edge locations and chord lengths at each of the sections so that your wing geometry approximates an ellipse.
   (e) Compare the efficiency of wings generated with only a few sections to those generated with many sections.
4. Explore the effects of vertical and horizontal tail volume ratios on the important stability derivatives of an airframe. Be sure to discuss desirable signs for stability derivatives. (see chapter 5 in the ME EN 415 textbook, specifically the static stability section.)

5. Explore the effects on angle of attack on the lift coefficient. Discuss the limitations of the VLM and explain which of your results are wrong due to those limitations.
   - It may be informative to think about how the VLM results differ from the results you got on the airfoil analysis assignment.
6. Write a short write-up on your methods, results, and takeaways. You should include introduction and discussion material on what you learned in steps 1-5, giving special attention to the methods and results from steps 3-5.
7. Submit your code and paper (.tex and .pdf files) via a pull request for your assignment branch on github. In this assignment we expect a higher level of coding. We will specifically be look for the following:
   - Most of your code should be written in functions, with a small script to call your functions. Functions are faster and more modular that writing everything in scripts. Every function should have a docstring explaining the purpose, inputs, and outputs.
   - All of your code should be well commented. This doesn't mean that every line must have a comment, but sufficient comments throughout are required. Comments should make the intent of the code explicit, as well as provide a road map. Any complicated line of code should be commented.

Hint: Here are some common terms that you may want to include in your appendix dictionary. You should also include other terms you come across that are unfamiliar.

- Coefficient of Drag (3D), C_D
- Coefficient of Lift (3D), C_L
- Coefficient of Moment (3D), C_M
- Wing Mean Aerodynamic Chord, $\overline{c}$
- Wing Span, b
- Wing Dihedral, ϕ
- Wing Twist, θ
- Wing Sweep, Λ
- Wing Aspect Ratio
- Tail Volume Ratios (horizontal and vertical)
- Inviscid Span Efficiency, e
- Airframe Stability Derivatives

Useful Resources

- ME EN 515 Book (chapter 4 specifically)
- ME EN 515 Book (chapter 5 specifically)
- VortexLattice.jl Documentation

- Google
- Adding wiki pages to your repository.