EMA 521 (Aerodynamics) Exam 1 Equation Sheet

Emmett Galles

Fall 2020

This document aims to include all equations needed for the first exam for EMA 521 at UW-Madison during the Fall 2020 semester. In addition to the equations, I hope to add some notes that assist the reader in using the correct equation.

I welcome feedback on this document. Please feel free to reach out to me by email at egalles@wisc.edu to share your thoughts or concerns. This document was generated on October 18, 2020; for the most recent edition, please visit GitHub (link).

"It is not the critic who counts; not the man who points out how the strong man stumbles, or where the doer of deeds could have done them better. The credit belongs to the man who is actually in the arena, whose face is marred by dust and sweat and blood; who strives valiantly; who errs, who comes short again and again, because there is no effort without error and shortcoming; but who does actually strive to do the deeds; who knows great enthusiasms, the great devotions; who spends himself in a worthy cause; who at the best knows in the end the triumph of high achievement, and who at the worst, if he fails, at least fails while daring greatly, so that his place shall never be with those cold and timid souls who neither know victory nor defeat."

- Theodore Roosevelt

Table of Contents

0 Important terminology and comments

This class uses jargon that is often hard to keep track of. The following is a list of terms we frequently use:

- **Upstream/freestream:** this is the region in front of the wing/object we are studying. It is often denoted by the $_\infty$ subscript.
- **Angle of attack α:** the angle that the leading edge of the airfoil makes with the relative wind. Note that in Figure 0.1, the angle of attack α is positive.
- **Chord c:** the straight-line distance between the leading edge and trailing edge; the length of the chord line from Figure 0.1.
- **Camber:** the distance between the chord line and the camber line.
- **Thickness t:** the actual thickness of the airfoil between the lower and upper surfaces. Note that this value can change depending on where we look at the airfoil!

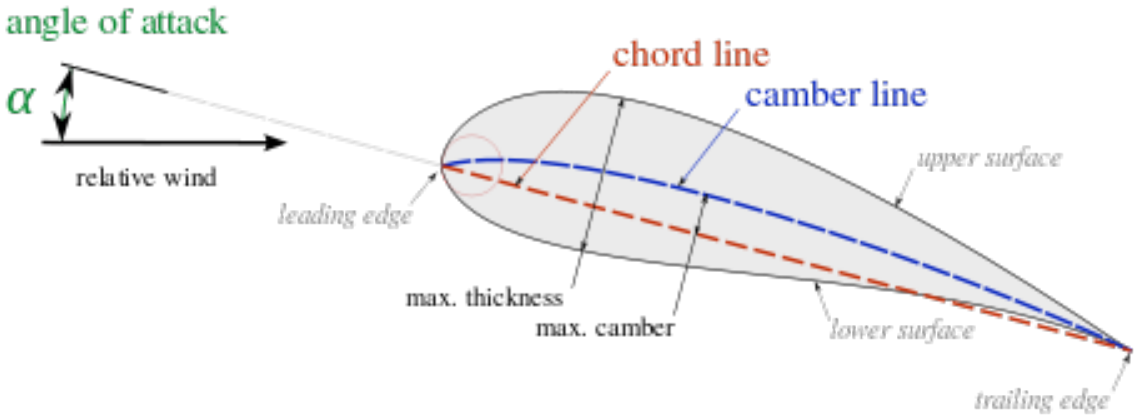

Figure 0.1: 2D airfoil with common terminology

Lift and drag forces are always with respect to the freestream flow! In other words, lift will always be perpendicular to the freestream flow and drag will always be parallel to the freestream flow. Axial and normal forces will be with respect to the orientation of the object of interest.

I will aim to explain any more jargon in the sections in which they appear.

1 Aerodynamic forces