EAE 127 Applied and Computational Aerodynamics

Project 3
Elementary Potential Flows

1 Freestream/Source Superposition

Derive the equations for the stagnation point and dividing streamline of a source in freestream flow, starting with Eqn. 3.75 in Anderson **(for practice with LaTeX)**. Create a code to simulate the superposition of freestream flow and a potential flow source (Freestream velocity $V_\infty = 1$). For a source strength of $\Lambda = 5$, **plot the streamlines, velocity potential contours, dividing streamline, dividing streamline diameter, source location, and stagnation point location** (Reference AeroPython Lesson02 by Lorena Barba for help in setting up your potential flow code). Use the streamplot function to plot streamlines and the contour function to plot the velocity potential.

Next, **plot the dividing streamline diameter** (grey arrow in Fig. 1) as a function of source strength, and **describe this relationship.**

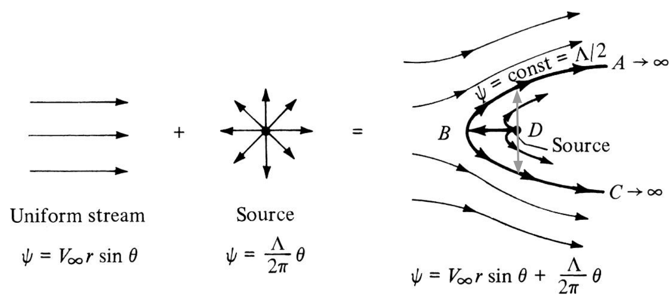

Fig. 1: Freestream+source superposition showing dividing streamline

2 Potential Flow Airfoil Representation

In potential flow, any streamline can be thought of as a solid body, since no flow will cross its boundary, by definition. **Approximate the first three quarters of the geometry** of the symmetric NACA 0017 at $\alpha = 0^o$ (non-lifting flow) with a **distribution of ten or more sources and sinks along the chord line**. Select singularity strengths and locations such that the dividing streamline closely resembles the airfoil surface geometry (ensure that the sum of the strengths of all of the sources and sinks is zero so that the dividing streamline is a closed body). Use trial and error to find the best singularity distribution (no need to solve a system of linear equations, this is not a panel method...that's the next project).

For at least three of your trials of singularity distributions, **plot airfoil geometry, dividing streamline of the source distribution, and singularity locations** in a single figure. **Quantify the error** of the approximation of each by the sum of the magnitude of the difference between the NACA 0017 geometry and the dividing streamline profile. **Discuss the advantages and limitations** of this method of approximating flow over an airfoil. How might this method be improved to produce more accurate results?

3 More Potential Flow

Perform the infinite row of vorticies problem from AeroPython. **Plot streamlines for the infinite solution**. Attempt to approximate the infinite solution with a finite number of vortex elements. **Plot mulitple iterations** to show how the approximation approaches the infinite solution. **How might** this concept of a "wall" in potential flow be used for more complex simulations?