6.1. Using the identity given in equation (6.10), show that the vorticity distribution

\[ \gamma(\theta) = 2\alpha U_\infty \frac{1 + \cos \theta}{\sin \theta} \]

satisfies the condition that flow is parallel to the surface [i.e., equation (6.8)]. Show that the Kutta condition is satisfied. Sketch the \(2\gamma/U_\infty\) distribution as a function of \(x/c\) for a section lift coefficient of 0.5. What is the physical significance of \(2\gamma/U_\infty\)? What angle of attack is required for a symmetric airfoil to develop a section lift coefficient of 0.5?

Using the vorticity distribution, calculate the section pitching moment about a point 0.75 chord from the leading edge. Verify your answer, using the fact that the center of pressure \(x_c\) is at the quarter chord for all angles of attack and the definition for lift.

\[ \text{Kutta Condition} \quad \gamma(\theta) = 0 \]

\[ \gamma(\theta) = 2\alpha U_\infty \frac{1 + \cos(\theta)}{\sin(\theta)} \left( \frac{0}{\theta} \right) \]

\[ \text{Method 1) } \lim_{\theta \to 0} \frac{f(\theta)}{g(\theta)} = \lim_{\theta \to 0} \frac{f'(\theta)}{g'(\theta)} \]

\[ \gamma(\theta) = 2\alpha U_\infty \frac{-\sin(\theta)}{\cos(\theta)} = 2\alpha U_\infty \frac{0}{1} \to 0 \text{ is satisfied.} \]

\[ \text{Method 2) } \text{Plot} \frac{1 + \cos \theta}{\sin \theta} \]

\[ \text{grows to zero at } \pi \]
\[ \alpha \text{ required for } C_e = 0.5 \]

\[ C_e = 2\pi \alpha \]

\[ \alpha = \frac{C_e}{2\pi} = \frac{0.5}{2\pi} = 0.07958 \text{ rad} \]

\[ \alpha = 4.559^\circ \]

**Sketch**

\[ \frac{2\pi}{u_0} \text{ vs } \frac{x}{C} \]

\[ @ C_e = 0.5 \Rightarrow \alpha = 0.07958 \text{ rad} \]

\[ \frac{x}{C} = \frac{1}{2} \left( 1 - \cos \theta \right) \quad \theta = \cos^{-1} \left( 1 - \frac{2x}{C} \right) \]

\[ \frac{2\pi}{u_0} = \frac{2}{u_0} \times u_0 \quad \frac{1 + \cos \theta}{\sin \theta} = 4 \left( 0.07958 \right) \quad \frac{1 + \cos \theta}{\sin \theta} = 0.3143 \quad \frac{1 + \cos \theta}{\sin \theta} \]

![Graph](image-url)