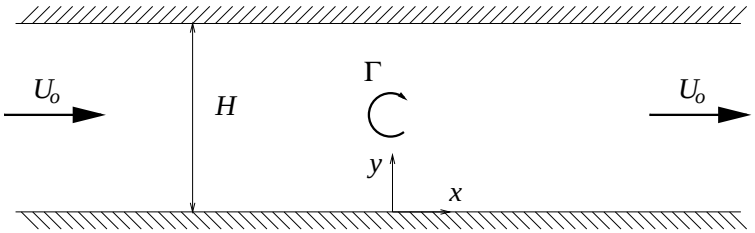
MAE 210B – FLUID MECHANICS II – SPRING 2017

HOMEWORK ASSIGNMENT # 3 (Due on May 3, 2017)

Problem 1: The sketch below represents a model problem to investigate the flow in a wind tunnel of height H with uniform velocity U_o. The presence of the airfoil is represented by a line vortex of negative circulation $-\Gamma$ located at $z = iH/2$. To solve the problem consider the conformal transformation $Z = \exp[\pi z/H]$.

- Obtain the complex potential $f(z)$.
- Determine the velocity and pressure along the upper wall.
- Calculate the location of the stagnation points in terms of $K = \Gamma/(2U_oH)$.
- Represent schematically the streamlines for $K < 1$, $K = 1$, and $K > 1$.



Problem 2: Consider the effect of the Joukowski transformation $Z = z + a^2/z$ on the circle $z = -\beta + i\lambda + [(a+\beta)^2 + \lambda^2]^{1/2} e^{i\gamma}$ with $0 \le \gamma \le 2\pi$, verifying that it maps onto a curved airfoil with finite thickness. Plot the resulting airfoil shape for $\beta/a = 0.5$ and $\lambda/a = 0.5$. Use the transformation to study the flow over the airfoil when flying with angle of attack α. Obtain the complex potential $F(Z)$. Use the Kutta condition to determine the circulation. Simplify the result when $\alpha \ll 1$, $\beta/a \ll 1$, and $\lambda/a \ll 1$. Obtain in that case the lift coefficient.