EAE 127 Applied and Computational Aerodynamics

Project 1

Introduction to Aerodynamics and Python

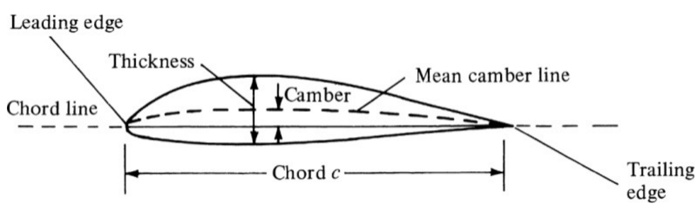
DUE: Monday, 10/05/2015, 2pm
TA: Logan Halstrom, Office Hours: W 1-2pm, R 3pm-4pm, CAE

PROBLEM 1

Plot the geometry of the symmetric NACA 0012 airfoil given the following thickness distribution equation:

$$z_t = \frac{t}{0.2} c \left[0.2969\sqrt{\frac{x}{c}} - 0.1260\left(\frac{x}{c}\right) - 0.3516\left(\frac{x}{c}\right)^2 + 0.2843\left(\frac{x}{c}\right)^3 - 0.1015\left(\frac{x}{c}\right)^4\right]$$

Where x is the distance along the chord line from the leading edge, z is the distance from the leading edge perpendicular to the chord line, t is the ratio of maximum thickness (τ) to chord (c) (t = 0.12). Reference Anderson Aerodynamics Figure 4.8 for airfoil geometry nomenclature:



Plot the geometry of the cambered NACA 2412 airfoil, which has the same thickness distribution as the NACA 0012 centered about the camber line given in the following equation:

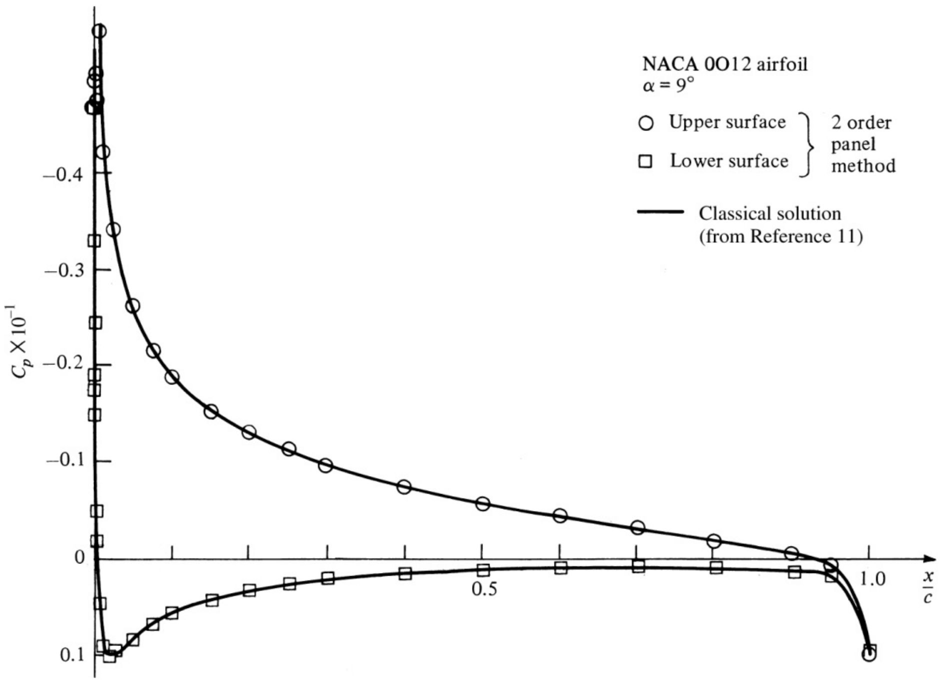
$$z_c = \begin{cases} m\frac{x}{p^2}\left(2p - \frac{x}{c}\right), & 0 \le x \le pc \\ m\frac{c-x}{(1-p)^2}\left(1 + \frac{x}{c} - 2p\right), & pc \le x \le c \end{cases}$$

Where m is the ratio of maximum camber to chord length (m = 0.02) and p is the chord-wise location of maximum camber non-dimensionalized by chord length (p = 0.4). For both airfoils, use a chord length of c=1, and **plot the camber line as a dashed line**.

PROBLEM 2

Plot the pressure field for the NACA 0012 airfoil at $\alpha = 8°$ in a contour plot. Flow field pressure coefficient is given in the file 'naca0012_a8_Cp.dat', and the flow field mesh is given in the files 'naca0012_a8_x.dat' and 'nacaX0012_a8_z.dat'. **Comment on interesting flow characteristics and the effects these might have on induced aerodynamic forces.**

Plot the surface pressure distribution, negative pressure coefficient against non-dimensional location along the chord (i.e. $-C_p$ vs. x/c), for each airfoil at $\alpha = 0, 8°$. **Comment on the characteristics of the pressure distribution and the effect of camber and angle of attack on surface pressure distribution.** Positive surface pressure coefficient is given for each case in the files 'nacaXXXX_aX_SurfCp.dat'.



Calculate lift, drag, and pitching moment coefficients by numerically integrating surface pressure values. (Reference Anderson Aerodynamics equations 1.15, 1.16, 1.7, 1.8, 1.1, 1.2).

Calculate center of pressure location (x_{CP}) for each case and **indicate it** on the surface pressure plots.