2.23 Hydrofoils & Propellers
Homework Assignment #4
Assigned: Monday Mar. 19, 2007
Due: Friday Apr. 6, 2007

1) A two-dimensional section has a parabolic mean line with \( \frac{f_{\text{max}}}{c} = 0.08 \) and an angle of attack \( \alpha = \) ideal angle of attack. Assume \( \rho = 1000 \text{ kg/m}^3 \), Chord = 0.5m and \( U_0 = 10 \text{ m/s} \)

   a) Find the Lift on the section
   b) Find the moment about the leading edge of the foil \( x/c = -0.5 \) ( \( M(x) = \rho U_0 \int x \gamma(x) \text{d}x \) )
   c) Find the location of the center of Lift (place about which moment = 0)

2) A two-dimensional section has a parabolic mean line, and is to develop a lift coefficient of \( C_l = 0.25 \) at its ideal angle of attack. The foil runs at a cavitation number \( \sigma = 0.6 \).

   a) Find the camber height to achieve this lift coeff. (at ideal angle of attack).
   b) Plot the pressure coefficient on the upper and lower surface (Plot –\( C_p \) vs \( x/C \) ).
   c) Find the maximum angle of attack before the foil cavitates at the quarter-chord point (\( x = -c/4 \))

3) Given a 2D foil geometry defined as follows:
   i. \( f(x)/c = 0.3 \ (x/c)^3 - 0.12(x/c)^2 - 0.18(x/c) \)
   ii. Angle of attack = 2 degrees
   iii. Elliptical thickness form \( w/ \) \( to/c = 0.02 \) (note: leading edge radius for elliptical thickness is given by \( R_l = 0.5((to/c)^2) \))

   Find the following assuming linear foil theory(given \( x=0 \) is midchord, \(-c/2 \) is leading edge, \( c/2 \) is the trailing edge):

   a) Lift Coefficient \( C_l \)
   b) Ideal angle of attack
   c) \( u/U \) on the upper surface at \( x=0 \) (midchord)
   d) \( q/U \) at the leading edge (using Lighthill correction)
4) Using linearized 2D foil theory for a foil with the following geometry:

   i. Parabolic meanline \( f_0/c = 0.07 \)
   ii. Angle of attack = 3 degrees
   iii. Elliptical Thickness \( t_0/c = 0.04 \)

a) Find the Lift coefficient and the value of \( \Upsilon(x) \) at \( x/c = 0.25 \)

b) Plot \( C_{p\text{min}} \) vs \( x/C \) and find the location and value of \( C_{p\text{min}} \) on this foil