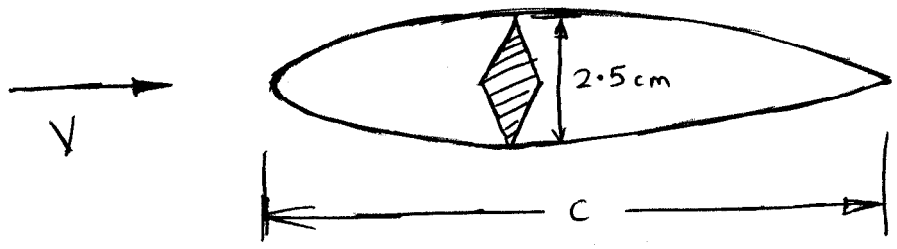
MAE 551, Airfoil Theory
Project 1

Problem 1 (100 points)

You have been called on to design a low-drag fairing for a UAV. The purpose of the fairing is to streamline an antenna of width 2.5 cm (see sketch, same as from previous homework) that is exposed to the freestream. In HW 3, you used the NACA 63-010A airfoil as a baseline and found the optimum values of $(t/c)_{max}$ for minimizing the fairing drag at zero alpha at two flight speeds.



In this project, your objective is to design two "best" airfoils for the fairing using PROFOIL, MFOIL, and XFOIL. Use MFOIL/PROFOIL for inverse design and XFOIL for post-design analysis. Design the two "best" airfoils for flight speeds of 60 m/s (first airfoil) and 30 m/s (second airfoil), assuming standard sea-level atmospheric conditions ($\rho = 1.23$ kg/m^3 and $\nu = 1.46\times10^{-5}$ m^2/s). The "best" airfoil for each flight speed is one that minimizes Drag per unit span, D', for α from 0 deg to 2 deg for that flight speed.

Your results should include (1) two PROFOIL input files (included as Appendices to your document) that correspond to your two optimum airfoils for the two flight speeds (the final airfoils at the correct thickness-ratios should be designed using PROFOIL and should not be scaled versions), (2) plots of the two airfoil geometries with the antenna enclosed, (3) the values of the C_d, c, and Drag per unit span, D', in Newton/m for the two "optimum" airfoils for α of 0 deg and 2 deg, (4) C_p distributions for the two airfoils at $\alpha = 0$ and 2 deg, and (5) figure of merit (FOM) . FOM, which is to be maximized, is $1/D'_{avg}$. D'_{avg} is the average of the four D' numbers (two conditions each for the two airfoils) corresponding to the two airfoils and $\alpha = 0$ deg and 2 deg.

Note that this is an open-ended assignment, with no single, known answer. Also, it has to be completed in the time provided, just like in a real-world design situation. Do the best you can in the time available.