EAE 127 Applied and Computational Aerodynamics

Project 7

Nonlinear Numeric Lifting-Line Method for Finite Wings

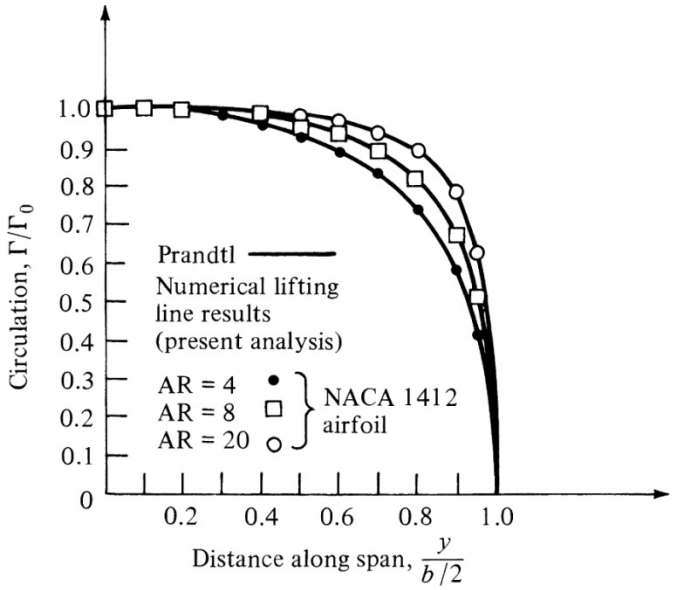
Submit iPython Notebook as a .ipynb file and as a .html file ('Run All' before downloading)
DUE: Monday 12/1/2015 2:10pm

Problem 1

Create a nonlinear numerical lifting-line algorithm as detailed in Anderson's Fundamentals of Aerodynamics Section 5.4. Attempt to reproduce Anderson's results for an untwisted rectangular wing with a NACA 1412 section with the following properties:

Aspect Ratio	Wingspan	Angle of Attack	Freestream Velocity
AR = 20	b = 1	$\alpha = 0°$	$V_\infty = 1$

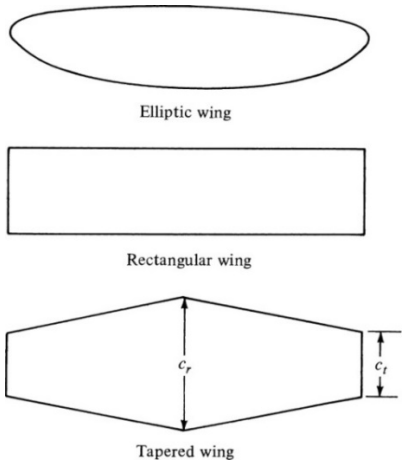
Obtain nonlinear sectional lift coefficient data from XFOIL with Re=1e5 for iteration of the sectional lift distribution over the wing. **Plot results for the circulation distribution** against Anderson's in the same form as Figure 5.29 below and **comment on the accuracy** of your solution:



Problem 2

Using the method from Problem 1, solve for the lift distributions over various wings and observe the aerodynamic effects of wing geometry characteristics. Consider the tapered wing of the P-51D Mustang from Project 5 (with the airfoil section from Problem 1 of this project for simplicity):

Wing Area (S) :	235 ft^2
Wingspan (b)	50 *ft*
Root Chord Length (c_r) :	8.48 *ft*
Cruise Speed (V_{cruise})	362 *mph*
Geometric Cruise Altitude (h) :	23000 *ft*
Loaded Weight (W) :	9200 *lbs*



For this tapered wing, and for an elliptic wing and a rectangular wing of equal planform area and wingspan, **plot the planform geometries** and then compute and **plot the circulation distributions** and **effective angle of attack distributions** in **two total plots** for all wings at $\alpha=5°$. **Comment on the differences**.

Next, **perform an alpha sweep** (**up to stall** at least) for all wings. **Plot the lift curves** (C_L vs. α) and the **drag polars** (C_L vs. C_D) of each wing in **two total plots** and **comment on the differences** between the wings. What is the **Aspect Ratio** of each wing? Which wing has the **best performance**? From Project 5, **what will α_{cruise} be** for the P-51D with the tapered wing in this analysis? **How does it compare** to your results for Project 5?