Assignment #2: Analysis of the Aerodynamic Performance of Various Wings by Using XFLR5 Software.

Consider a reference wing geometry with constant chord length of \( c = 12'' \), half wing span of \( b/2 = 30'' \), zero sweep, zero washout, and zero dihedral angle. Note that the planform area of this rectangular reference wing is \( S = b \times c = 720 \text{ in}^2 \) and aspect ratio is \( AR = b^2/S = 5 \). Then, build two wings with this reference wing geometry such that the \textbf{wing#1} uses ClarkY airfoil and the \textbf{wing#2} uses another airfoil you will choose from the airfoil database. Then, perform the following two case studies:

(1) Make a comparative analysis of \textbf{wing#1} and \textbf{wing#2} by choosing VLM (vortex lattice method) in XFLR5 in terms of \( \alpha - C_L \), \( C_D - C_L \), \( \alpha - C_M \), and \( \alpha - L/D \) graphs. Keep the \( Re \) number at about 300,000 in wing analysis by accordingly choosing the airspeed. Also find the aerodynamic center (a.c.) of both wings by using \( \alpha - C_M \) plots. \textbf{(Note that} you must first run a batch analysis of the two airfoils in a relevant range of \( Re \) numbers and angle of attacks). Also compare airfoil data with the wing data and comment on results (such as L/D ratios, lift slope – prediction vs. XFLR results, etc.). Please note that this comparison should be made at the same \( Re \) number.

(2) Similarly, perform the comparative analysis of following wings that use only ClarkY airfoil:

   (i) rectangular reference wing (i.e, \textbf{wing#1} as described above),

   (ii) tapered wing (\textbf{wing#3}) with the same area (\( S \)) and same aspect ratio (\( AR \)). Use a taper ratio of 0.6 and show the wing’s planform. \textbf{(Note that} \( Re \) numbers must be the same in comparison. But you will see that mean aerodynamic chord “MAC” in tapered wing is almost the same as the chord length in rectangular wing for the taper ratio used, so there is no need to play with airspeed to match the \( Re \) numbers).

   (iii) another rectangular wing (\textbf{wing#4}) with the same area (\( S \)) but a shorter aspect ratio of \( AR = 3.5 \). \textbf{(Note that} in this case chord length will be significantly larger, so you must decrease the airspeed in XFLR5 analysis to match the \( Re \) numbers).

Report must be prepared in a professional format by paying attention to detail, particularly in the graphs and equations (please see “assignment/report format” document posted at the website).