Airfoil Characterization

23 Mar 06

Lab 7 Lecture Notes B

Six airfoils suitable for a multipurpose light electric aircraft are shown overlaid in Figure 1. The thickness/chord ratios vary from $\tau = 0.07$ to $\tau = 0.12$. Computed drag polars are shown in separate plots. The drag coefficient is in effect a function of the three variables (c_ℓ, Re, τ). For optimization calculations, it is desirable to approximate this function, preferably with explicit formulas. A suitable approximation is

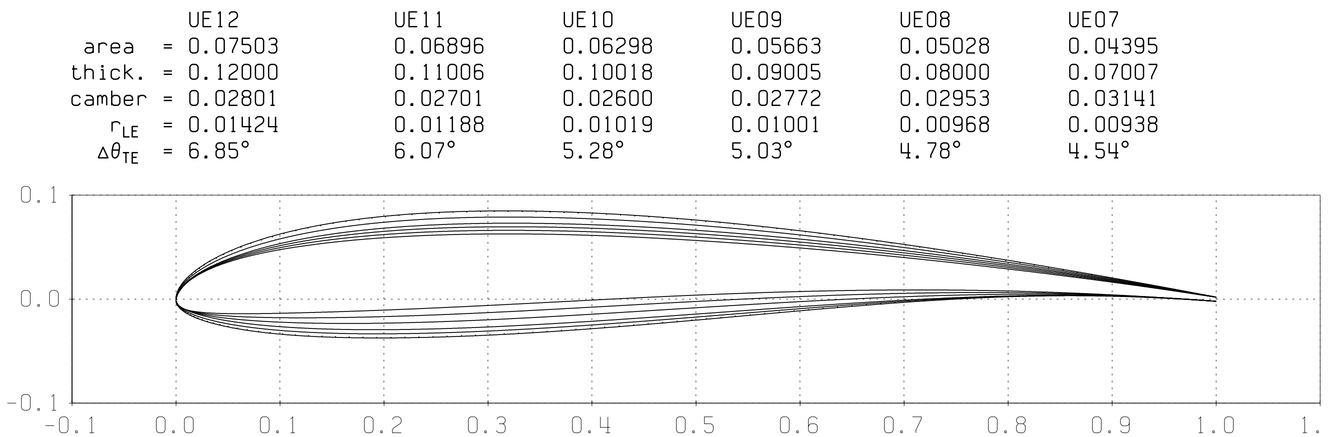

Figure 1: Six airfoils suitable for light electric aircraft.

$$c_d(c_\ell, Re, \tau) \;\;\simeq\;\; \left[c_{d_0} + c_{d_2}(c_\ell - c_{\ell_0})^2\right]\left(1 + k_\tau \tau^3\right)\left(\frac{Re}{Re_{\rm ref}}\right)^a \qquad (1)$$

where the constants are set to match the computed polars over narrow parameter ranges of interest.

The following constants give a reasonable approximation for the “slow” range, $0.8 \le c_\ell \le 1.0$, $40000 \le Re \le 60000$.

$$c_{d_0} = 0.020 \qquad (2)$$
$$c_{d_2} = 0.05 \qquad (3)$$
$$c_{\ell_0} = 0.8 \qquad (4)$$
$$k_\tau = 350 \qquad (5)$$
$$Re_{\rm ref} = 50000 \qquad (6)$$
$$a = -0.8 \qquad (7)$$

The following constants give a reasonable approximation for the “fast range, $0.2 \le c_\ell \le 0.3$, $80000 \le Re \le 120000$.

$$c_{d_0} = 0.0115 \qquad (8)$$
$$c_{d_2} = 0.0 \qquad (9)$$
$$c_{\ell_0} = 0.2 \qquad (10)$$
$$k_\tau = 350 \qquad (11)$$
$$Re_{\rm ref} = 100000 \qquad (12)$$
$$a = -0.5 \qquad (13)$$