

# Airfoil Characterization

## Lab 7 Lecture Notes B

23 Mar 06

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

	UE12	UE11	UE10	UE09	UE08	UE07
area	= 0.07503	0.06896	0.06298	0.05663	0.05028	0.04395
thick.	= 0.12000	0.11006	0.10018	0.09005	0.08000	0.07007
camber	= 0.02801	0.02701	0.02600	0.02772	0.02953	0.03141
$r_{LE}$	= 0.01424	0.01188	0.01019	0.01001	0.00968	0.00938
$\Delta\theta_{TE}$	= 6.85°	6.07°	5.28°	5.03°	4.78°	4.54°

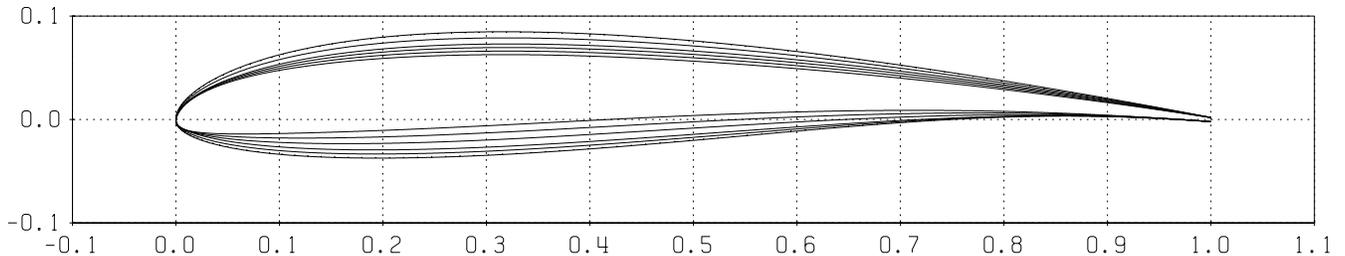


Figure 1: Six airfoils suitable for light electric aircraft.

separate plots. The drag coefficient is in effect a function of the three variables ( $c_\ell$ ,  $Re$ ,  $\tau$ ). For optimization calculations, it is desirable to approximate this function, preferably with explicit formulas. A suitable approximation is

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

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,  $0.8 \leq c_\ell \leq 1.0$ ,  $40000 \leq Re \leq 60000$ .

$$c_{d_0} = 0.020 \quad (2)$$

$$c_{d_2} = 0.05 \quad (3)$$

$$c_{\ell_0} = 0.8 \quad (4)$$

$$k_\tau = 350 \quad (5)$$

$$Re_{\text{ref}} = 50000 \quad (6)$$

$$a = -0.8 \quad (7)$$

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

$$c_{d_0} = 0.0115 \quad (8)$$

$$c_{d_2} = 0.0 \quad (9)$$

$$c_{\ell_0} = 0.2 \quad (10)$$

$$k_\tau = 350 \quad (11)$$

$$Re_{\text{ref}} = 100000 \quad (12)$$

$$a = -0.5 \quad (13)$$