MAE 253 – Experimental Aerodynamics I
Lab 3 – Airfoil Aerodynamics (Lift)

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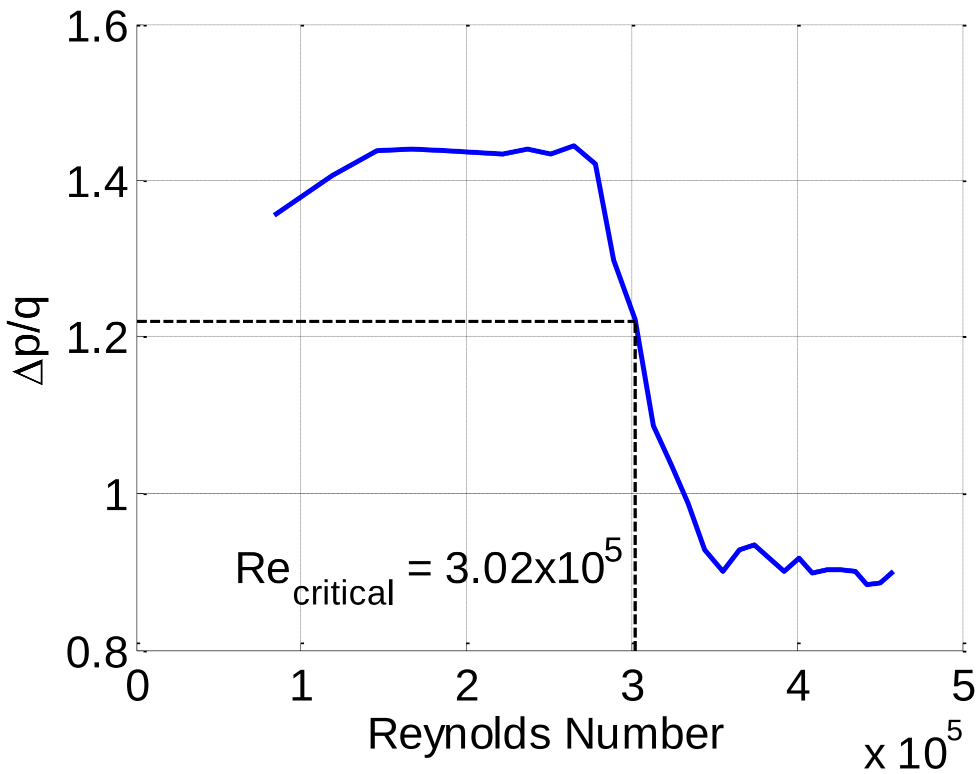
Outline

- Lab 2 - Solutions
- Lab 3 - Objective
- Lab 3 – Theory
- Lab 3 - Expectations

Lab 1 - Solutions



TF (average) = 1.2512

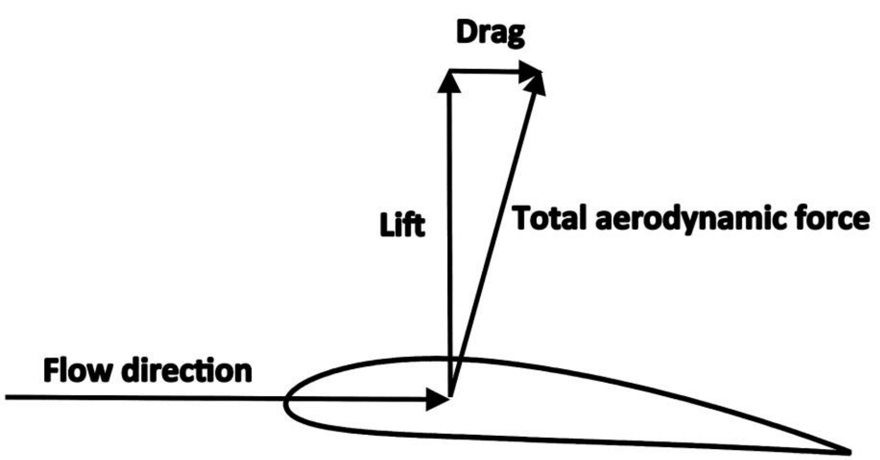
% turbulence (average) = 0.2998

Lab 3 - Objective

- Basic understanding of the multi-port pressure measurement system.
- Insight into basic automation techniques in experimental aerodynamics research.
- Study the lift characteristics of the airfoil.

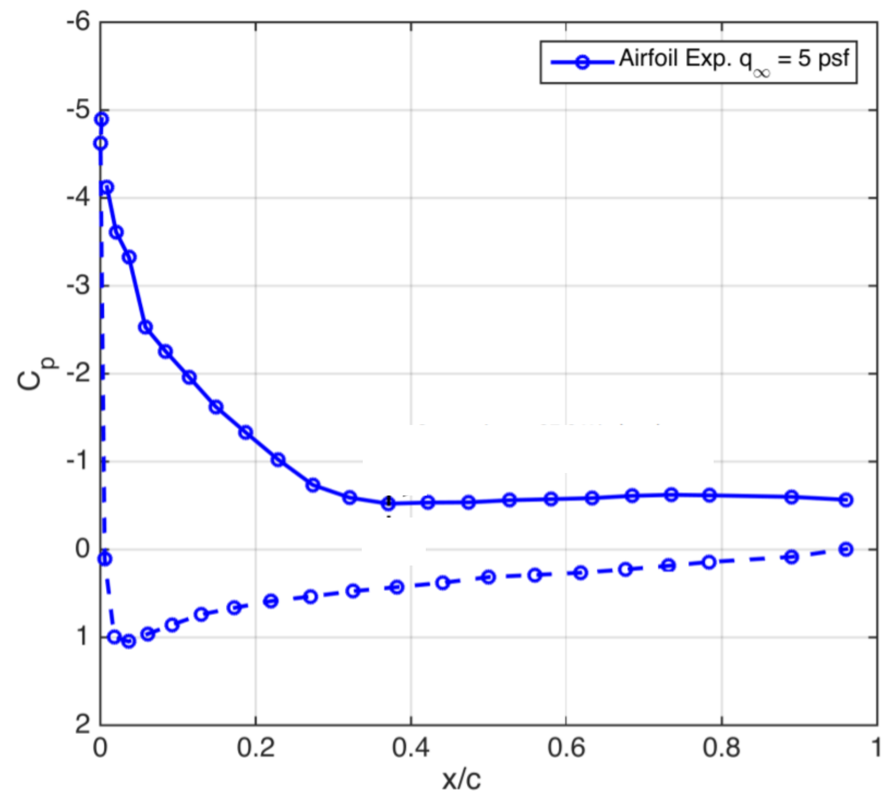
Lab 3 - Theory

- Lift is the perpendicular (to oncoming flow direction) component of the force exerted on a body due to the fluid flow.
- The lift coefficient is a number that aerodynamicists use to model all of the complex dependencies of shape, inclination, and some flow conditions on lift.
- $C_l = \dfrac{L}{\frac{1}{2}\rho_\infty V_\infty^2 \, c}$
  - C_l – coefficient of lift
  - L – lift force
  - ρ – density of fluid
  - V_∞ - freestream velocity
  - c – airfoil chord



Lab 3 - Theory

- The pressure coefficient is a parameter for studying low-speed flow of compressible fluids such as air.
- $C_p = \dfrac{p - p_{\infty,static}}{\frac{1}{2}\rho_\infty V_\infty^2}$
  - p – static pressure at point of measurement
  - p_∞ - freestream static pressure
- The Scanivalve system directly provides gauge pressure.
- Area under the C_p curve gives us the lift coefficient.
  - $C_l = \frac{1}{c}\int_0^c \left(C_{p,lower} - C_{p,upper}\right)dx$
  - In MATLAB, the trapz() function gives you the area under a curve.



Lab 3 – Expectations

- Data acquired:
  - Static pressure data at different angles of attack and Reynolds numbers.
  - 10 readings per angle of attack.
- Co-plot the C_p distributions at all angles of attack for a given Reynolds number.
- Plot the C_l vs. α curve for the airfoil with error bars and compare the data to XFOIL predictions.

- Constants:
  - airfoil chord, $c = 0.3048$m
  - density, $\rho_{air} = 1.185$ kg/m^3
  - dynamic viscosity, $\mu_{air} = 1.846 \times 10^{-5}$ Pa s
  - TF = 1.2512