UNIT 5 - AERODYNAMIC FORCES

LIFT

The following variables are taken into account when calculating lift:

Variable	Name	Units
$\frac{1}{2}\rho V^2$	Dynamic Pressure	Units: N/m² (Pascal)
ρ (rho)	Air density	ISA Units: 1.225 kg/m³
V	Relative Velocity	Unit: m/s
S	Wing Area	Unit: m²
C_L	Lift Coefficient	The lift coefficient is a non-dimensional value that varies with angle of attack (AoA) and is a re-arrangement of the lift formula. This value is normally determined during wind tunnel tests

The lift formula can be summarised as follows:

$$L = \frac{1}{2}\rho V^2 \cdot S \cdot C_L$$

COEFFICIENT OF LIFT

There are many factors that affect the amount of lift an aerofoil generates. By varying the angle of attack (AoA) the coefficient of lift (C_L) changes. If we take a symmetrical aerofoil and place it in a wind tunnel and use a fan to generate a constant airflow with velocity (V) and constant density (ρ), we can use the lift formula at each AoA to determine the C_L using a dynamometer to measure the dynamic pressure.

Using this method, we can measure lift and obtain a C_L value for every AoA by plotting this on a curve. As the AoA is increased, the C_L increases proportionally until we reach a point called the Maximum Coefficient of Lift (C_L Max). After this point, no more lift can be produced as we have boundary layer separation along with an increase in drag.

If we increase the angle of attack further, we reach what is called the Stall or Critical Angle of Attack (α_{CRIT}). After this point, the lift decreases dramatically and drag rises considerably, with the wing or aerofoil unable to sustain flight.

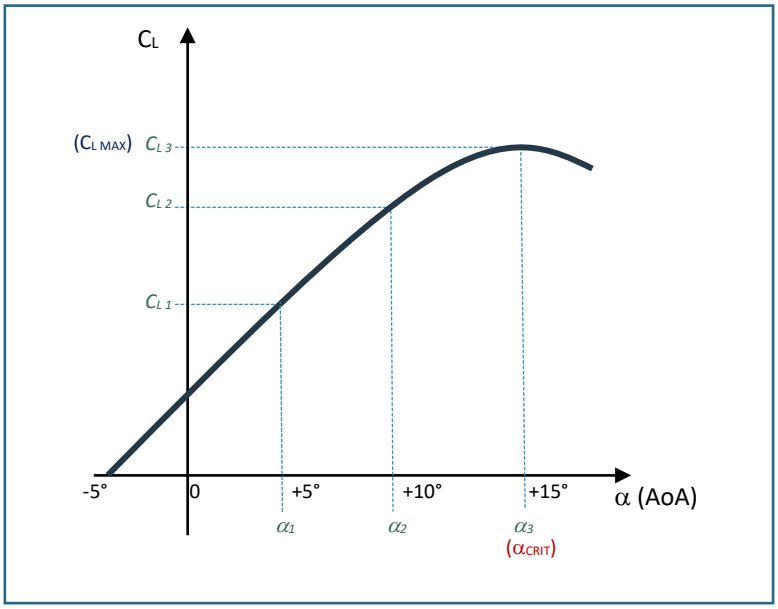

Figure 3 – Coefficient of Lift Vs. Angle of Attack (α)