SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF AEROSPACE ENGINEERING

23AST206 – AERODYNAMICS

II YEAR IV SEM

UNIT 1 – BASIC AERODYNAMICS AND FLUID MECHANICS

TOPIC – Aerodynamic forces and moments

AERODYNAMIC FORCES AND MOMENTS

Aerodynamic Force and Moment

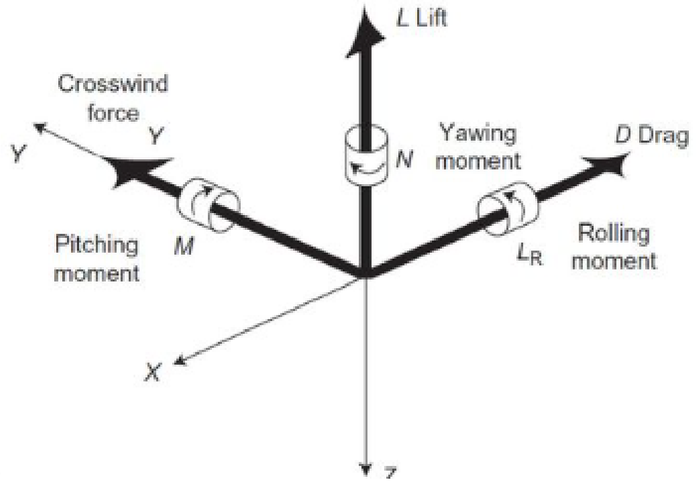
- Air flowing past an airplane, or any other body, must be diverted from its original path; such deflections lead to changes in air speed.

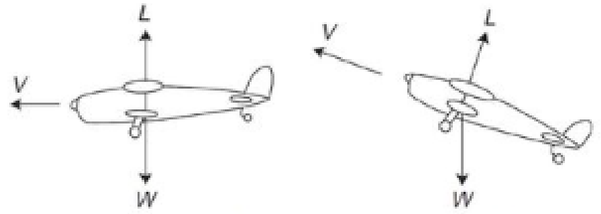
- Bernoulli's equation shows that the pressure exerted by the air on the airplane is altered from that of the undisturbed stream. Also, the viscosity of the air leads to frictional forces tending to resist the air's flow.

- As a result of these processes, the airplane experiences an aerodynamic force and moment. It is conventional and convenient to separate aerodynamic force and moment into three components each.

Aerodynamic Force and Moment

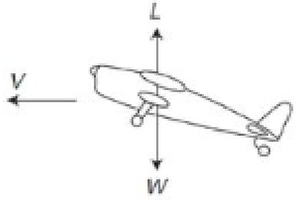
- Lift, L (CZ Direction)
- Drag, D(–X)
- Crosswind Force, Y
- Pitching Moment, M
- Rolling Moment, LR
- Yawing Moment, N



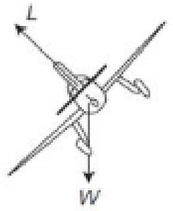


(a) High speed level flight

(b) Climbing flight



(c) Low speed level flight



(d) Banked circling flight

- We need **lift** for flying!
  - **Lift** is the component of the force that a fluid flowing past a surface of a body exerts on it on the direction perpendicular to the oncoming flow direction.
  - **Drag** is, in opposition to lift, the component of the force along the direction of the oncoming flow direction.

- How can we analyze aircrafts that are so different?

- Why airplanes can fly?
  - We can easily remember the basic flight equations:

$$\sum \vec{F} = m \cdot \vec{a}$$

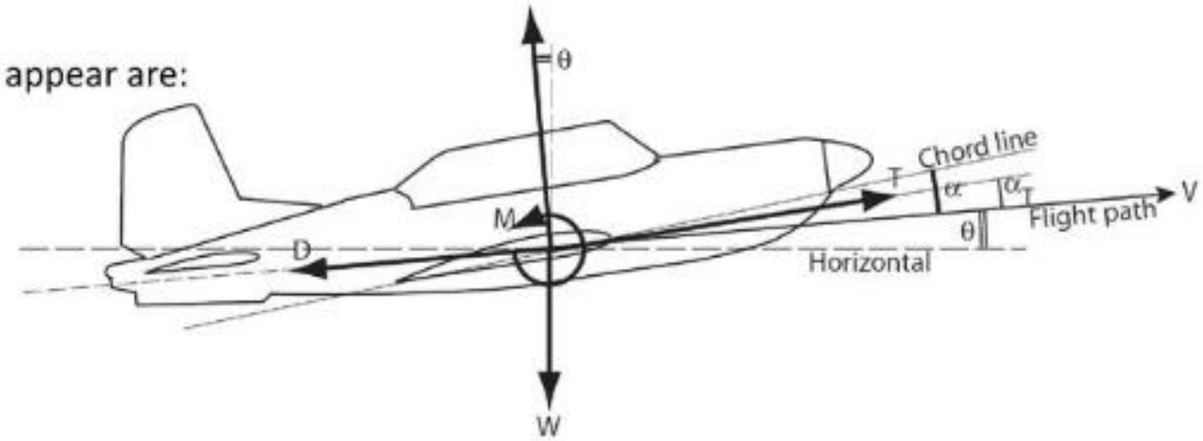
And the forces that appear are:

W = weight

L = lift

D = drag

T = thrust



  - If we wish to have a stable flight condition we have to compensate all the forces.

Considering a generic case with a sustained turn of radius r_c, we decompose this equation along the path direction:

$$\sum F_{\parallel} = T \cdot \cos \alpha_T - D - W \cdot \sin \theta = m \cdot \frac{dV}{dt}$$

$$\sum F_{\perp} = L - T \cdot \sin \alpha_T - W \cdot \cos \theta = m \cdot \frac{V^2}{r_c}$$


Thank You