SNS COLLEGE OF TECHNOLOGY
(An Autonomous Institution)

Department of Aerospace Engineering

23AST101-Fundamentals of Aerospace Engineering

UNIT-2:

History of Flight

AERODYNAMICS

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Aerodynamics is a crucial aspect of aircraft design and performance, as it deals with the forces acting on an aircraft as it moves through the air. The primary aerodynamic forces acting on an aircraft are lift, drag, thrust, and weight. These forces interact to determine the aircraft's motion and stability.

1. Lift

Definition: Lift is the upward force generated by the wings (or lifting surfaces) as air flows over them. It counteracts the aircraft's weight and allows the aircraft to rise and stay airborne.

How it works:

- Lift is created due to the pressure difference between the upper and lower surfaces of the wing.
- The shape of the wing (airfoil) is designed to accelerate air over the top surface, reducing pressure, while the lower surface experiences higher pressure.

- **Factors affecting lift:**
  - Air density (ρ)
  - Velocity of the aircraft (V)
  - Wing area (S)
  - Lift coefficient (C_L), which depends on the angle of attack and wing shape.
- **Equation:** $L = \frac{1}{2}\rho V^2 S C_L$

2. Drag

Definition: Drag is the resistance force acting opposite to the aircraft's motion through the air. It opposes thrust and must be overcome for the aircraft to move forward.

Types of drag:

Parasitic drag: Includes form drag (due to shape), skin friction (due to air viscosity), and interference drag (due to interactions between components).

Induced drag: Caused by the generation of lift, particularly at high angles of attack. It is related to the vortices formed at the wingtips.

- **Factors affecting drag:**
  - Air density (ρ)
  - Velocity (V)
  - Wing area (S)
  - Drag coefficient (C_D), which depends on the shape and angle of attack.
- **Equation:** $D = \frac{1}{2}\rho V^2 S C_D$

3. Thrust

Definition: Thrust is the forward force produced by the aircraft's engines or propulsion system. It overcomes drag and propels the aircraft through the air.

How it works: Thrust is generated by accelerating air (or exhaust gases) in the opposite direction of the aircraft's motion, following Newton's third law of motion.

Factors affecting thrust:

Engine type (jet, turboprop, piston, etc.)

Airspeed and altitude

Throttle setting

- **Equation:** $T = \dot{m}\Delta V$, where $\dot{m}$ is the mass flow rate of air and ΔV is the change in velocity of the air.

4. Weight

Definition: Weight is the downward force due to gravity acting on the aircraft's mass. It is countered by lift during flight.

Factors affecting weight:

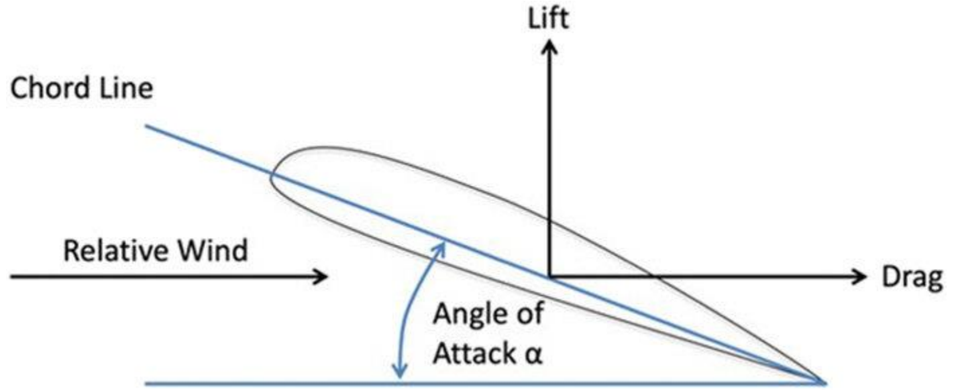
Aircraft mass (including fuel, payload, and structure)

Gravitational acceleration (g)

- **Equation:** $W = m \cdot g$

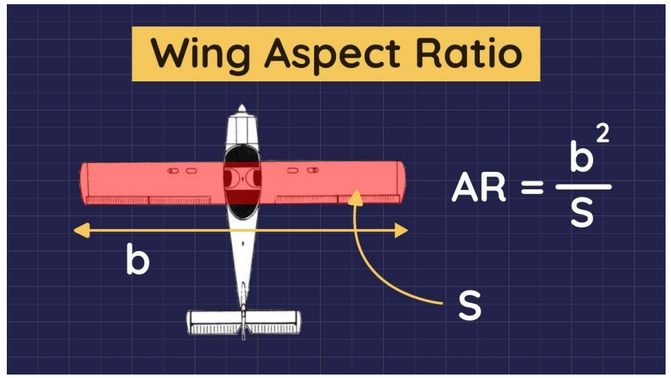
Balance of Forces in Flight

- **Steady, level flight**: Lift equals weight, and thrust equals drag.
  - L=W$L=W$
  - T=D$T=D$
- **Climbing**: Lift is less than weight, and thrust is greater than drag.
- **Descending**: Lift is less than weight, and thrust is less than drag.



Additional Aerodynamic Concepts

- **Angle of Attack (AOA)**: The angle between the wing's chord line and the oncoming airflow. It significantly affects lift and drag.
- **Stall**: Occurs when the angle of attack exceeds a critical value, causing a sudden loss of lift due to airflow separation over the wing.



Applications in Aircraft Design

- **Wing design**: Optimizing airfoil shape, aspect ratio, and wing area for efficient lift and reduced drag.
- **Drag reduction**: Streamlining the aircraft, using fairings, and minimizing surface roughness.
- **Control surfaces**: Ailerons, elevators, and rudders are used to control roll, pitch, and yaw by altering aerodynamic forces.


THANK YOU!