# SNS COLLEGE OF TECHNOLOGY

**An Autonomous Institution**
**Coimbatore – 35**

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Approved by AICTE , New Delhi and Affiliated to Anna University , Chennai.

## DEPARTMENT OF AEROSPACE ENGINEERING

## 19ASO301 BASICS OF AERONAUTICAL ENGINEERING

## UNIT 5 – AIRCRAFT INSTRUMENTS_1

# UNIT 5 – AIRCRAFT INSTRUMENTS

- *Atmosphere*
- *Flight Instruments & Navigation Instruments*
- *Gyroscope & Accelerometer*
- *Air Speed Indicators*
- *Altimeter*

# TEXT BOOK

- ***Anderson. J D, "Introduction to Flight", McGraw-Hill, 1995***

- ***Richard S. Shevel, "fundamentals of Flight", Prentice Hall, 2010***

# Air Speed Indicators

## Types of Air Speed

- *Indicated Air Speed (IAS)*
- *Calibrated Air Speed (CAS)*
- *True Air Speed (TAS)*
- *Equivalent Air Speed (EAS)*
- *Ground Speed (GS)*

# *Indicated Airspeed (IAS)*

- *The speed displayed on the air speed indicator, measured directly by the Pitot tube.*
- *It is a raw reading, uncorrected for altitude or temperature effects.*
- *As altitude increases, air density decreases, hence the speed indicated will be lesser than the actual speed.*
- *Conversely, at lower altitudes, air is dense and hence the speed indicated will be closer to the actual speed.*
- *IAS is important for low altitude flying, take off and landing*

# *Calibrated Airspeed (CAS)*

- *The speed of the aircraft through the air, corrected for instrument & position errors.*
- *It is generally used for flight performance calculations.*
- *It is the indicated airspeed, corrected for instrument and position errors.*
- *Instrument errors occur due to calibration of airspeed indicator itself.*
- *Position errors occur due to airflow disruption happening around the aircraft disrupting the static pressure readings, which can lead to inaccurate airspeed readings*

# *Calibrated Airspeed (CAS)*

- *It is derived based on the readings from the Aircraft's Pitot-static system, which measures the difference between Ram Air pressure and Static Pressure*

- ***Ram Air Pressure*** *- Ram air pressure, also known as stagnation pressure or total pressure, is the pressure exerted by the oncoming air due to an object's motion. It is measured using a Pitot tube. Force of air being "Rammed" into the object*

# True Airspeed (TAS)

- *TAS is the actual speed of an aircraft relative to the mass of the air, it's flying through.*
- *It represents the true velocity of the airplane, independent of wind speed or direction.*
- *The True Airspeed Indicator is a valuable tool for pilots to determine TAS .*
- *It is a mechanical or electronic device that factors in the altitude pressure and outside air temperatures (OAT) to calculate TAS.*
- *TAS is a critical parameter to know the time to destination, Fuel consumption pattern, Endurance, Engine performance, Diversionary airport etc.*

# True Airspeed (TAS)

*While the True Airspeed Indicator is a valuable tool, advancements in technology have led to alternative methods for determining TAS:*

- ***Flight Management System (FMS):*** *Modern aircrafts are equipped with FMS, which can calculate TAS based on the sensor inputs and aerodynamic data.*
- ***GPS based TAS Calculations:*** *Some GPS receivers can calculate TAS by factoring in wind speed and direction derived from satellite data.*

# True Airspeed (TAS)

*TAS plays a vital role in the meticulous process of flight planning:*

- ***Estimating En route Time:*** *TAS help pilots to determine the estimated time to reach their destination.*
- ***Fuel Planning:*** *TAS is factored into fuel consumption calculation.*
- ***Calculating Range:*** *Knowing TAS enables pilots to estimate the maximum distance an aircraft can travel with a specific fuel load.*
- ***Maintaining Control Characteristics:*** *TAS helps pilots to predict the behavior of an aircraft at different airspeeds, enabling them to maintain proper control throughout the flight.*

# True Airspeed (TAS)

- ***Preventing Stalls:*** *Pilots can evade engine stall, which is very crucial parameter in flight safety.*
- ***Staying within Airspeed Limits:*** *TAS awareness allows pilots to adhere to the safe operating limits of an aircraft.*

# Equivalent Airspeed (EAS)

- *EAS is the airspeed at sea level in the International Standard Atmosphere (ISA),that would produce the same dynamic pressure as the True Airspeed (TAS) and altitude the aircraft is flying.*

- *ISA is a model representing an ideal, static atmosphere, used as a reference for calculating and testing aircraft and engine performance, and for instrument calibration, particularly in aviation.*

- *Key values at sea level – Temp=15 deg, Pressure=1 Bar / 14.69 psi, Density=1.22Kg/cubic meter.*

# *Equivalent Airspeed (EAS)*

- *ISA specifies a temperature lapse rate of -6.5 deg C per kilometer or -2 deg per 1000 feet*

- *EAS is a useful measure for structural analysis and testing because aerodynamic forces and moments on an aircraft are proportional to the square of the equivalent airspeed, especially at Mach numbers below the onset of wave drag.*

# *CAS vs. EAS: Understanding the Difference*

- *Calibrated Airspeed (CAS) corrects for instrument & position errors, but doesn't account for air compressibility effects.*
- *At high speeds and altitudes, CAS readings become less accurate due to compressibility. This can lead to underestimating stall speed and exceeding safe engine limitations based on CAS alone.*
- *EAS incorporates a correction for compressibility, providing a more accurate representation of airspeed for critical performance calculations.*

# *Importance of EAS*

- *At high speeds, air compressibility can reduce the effectiveness of control surfaces like ailerons and rudders.*

- *CAS readings alone might not accurately reflect this decrease in control effectiveness.*

- *EAS provides a more accurate representation of how air behaves around the control surfaces, allowing pilots to adjust their control inputs accordingly.*

- *This ensures the aircraft responds as expected and maintains smooth handling speeds.*