
Module-7

Lecture-29

Flight Experiment: Instruments used in flight experiment, pre and post flight measurement of aircraft c.g.

Module Agenda

- Instruments used in flight experiments.
- Pre and post flight measurement of center of gravity.
- Experimental procedure for the following experiments.
 - (a) **Cruise Performance:** Estimation of profile Drag coefficient (C_{D_o}) and Oswalds efficiency (e) of an aircraft from experimental data obtained during steady and level flight.
 - (b) **Climb Performance:** Estimation of Rate of Climb RC and Absolute and Service Ceiling from experimental data obtained during steady climb flight
 - (c) Estimation of stick free and fixed neutral and maneuvering point using flight data.
 - (d) Static lateral-directional stability tests.
 - (e) Phugoid demonstration
 - (f) Dutch roll demonstration

Instruments used for experiments¹



1. **Airspeed Indicator:** The airspeed indicator shows the aircraft's speed (usually in knots) relative to the surrounding air. It works by measuring the ram-air pressure in the aircraft's Pitot tube. The indicated airspeed must be corrected for air density (which varies with altitude, temperature and humidity) in order to obtain the true airspeed, and for wind conditions in order to obtain the speed over the ground.
2. **Attitude Indicator:** The attitude indicator (also known as an artificial horizon) shows the aircraft's relation to the horizon. From this the pilot can tell whether the wings are level and if the aircraft nose is pointing above or below the horizon. This is a primary instrument for instrument flight and is also useful in conditions of poor visibility. Pilots are trained to use other instruments in combination should this instrument or its power fail.
3. **Altimeter:** The altimeter shows the aircraft's altitude above sea-level by measuring the difference between the pressure in a stack of aneroid capsules inside the altimeter

¹wikipedia

and the atmospheric pressure obtained through the static system. It is adjustable for local barometric pressure which must be set correctly to obtain accurate altitude readings. As the aircraft ascends, the capsules expand and the static pressure drops, causing the altimeter to indicate a higher altitude. The opposite effect occurs when descending.

4. **Turn Coordinator:** the turn and slip indicator (T/S) and the turn coordinator (TC) variant are essentially two aircraft flight instruments in one device. One indicates the rate of turn, or the rate of change in the aircraft's heading, the other part indicates whether the aircraft is in coordinated flight, showing the slip or skid of the turn. The slip indicator is actually an inclinometer that at rest displays the angle of the aircraft's lateral axis with respect to horizontal, and in motion displays this angle as modified by the acceleration of the aircraft.
5. **Heading Indicator:** The heading indicator (also known as the directional gyro, or DG; sometimes also called the gyrocompass, though usually not in aviation applications) displays the aircraft's heading with respect to magnetic north. Principle of operation is a spinning gyroscope, and is therefore subject to drift errors (called precession) which must be periodically corrected by calibrating the instrument to the magnetic compass.
6. **Vertical Speed Indicator:** The VSI (also sometimes called a variometer, or rate of climb indicator) senses changing air pressure, and displays that information to the pilot as a rate of climb or descent in feet per minute, meters per second or knots.
7. **Yoke:** A yoke, alternatively known as a control column, is a device used for piloting some fixed-wing aircraft. The pilot uses the yoke to control the attitude of the plane, usually in both pitch and roll. Rotating the control wheel controls the ailerons and the roll axis.
8. **Manifold pressure:** The manifold pressure gauge is an engine instrument typically used in piston aircraft engines to measure the pressure inside the induction system of an engine. The induction system of course being the air / fuel mixture that is between the throttle and the cylinders.

Experiment # 1

Pre and post flight measurement of a/c cg

Center of gravity is calculated as follows:

- Let:
 - X - Distance of the reference point from NOSE wheel
 - Y - Distance of the reference point from REAR wheel
 - N - Weight measured in nose wheel
 - L - Weight measured in left wheel
 - R - Weight measured in right wheel

- Use formula:

$$X_{cg} = \frac{(X \times N) + \{(L + R) \times Y\}}{L + R + N}$$

- Watch: Take-off Video: <https://www.youtube.com/watch?v=YIaBKjKYHIO>
- Watch: Landing Video: <https://www.youtube.com/watch?v=XiJ616XHknU>
- Watch: Taxiing Video: <https://www.youtube.com/watch?v=8FDk-UBMzvQ>