

Aircraft Stability and Control (AEPC3004)

Course Objectives

- To develop a fundamental understanding of aircraft stability (static & dynamic)
- To analyze control mechanisms and aircraft response to disturbances
- To study longitudinal, lateral, and directional stability
- To introduce modern flight control systems and handling qualities

Course Outcomes

After completing this course, students will be able to:

- Understand and analyze aircraft stability characteristics
- Evaluate dynamic response and modes of motion
- Design and assess control systems for aircraft
- Interpret handling qualities and pilot response

Prerequisites

- Fluid Mechanics
- Aerodynamics
- Engineering Mechanics / Dynamics
- Basic Flight Mechanics

Course Structure

Module 1: Introduction to Flight Dynamics (06 Hours)

Degrees of freedom of an aircraft; Forces and moments acting on an aircraft; Coordinate systems: Body axes, Stability axes, Wind axes; Euler angles and transformations, Equations of motion (nonlinear form)

Module 2: Static Stability (06 Hours)

Longitudinal Static Stability: Concept of static stability, Pitching moment and aerodynamic center, Neutral point and static margin, Effect of CG location, Tail volume ratio and tail effectiveness

Lateral & Directional Static Stability: Dihedral effect, Weathercock stability, Contribution of vertical tail, Sweepback effects, Spiral stability

Module 3: Control Surfaces and Trim (06 Hours)

Elevator, aileron, rudder: functions and effectiveness, Control derivatives, Trim conditions: Longitudinal trim and Lateral-directional trim, Stick-fixed and stick-free stability, Control forces and hinge moments

Module 4: Dynamic Stability (06 Hours)

Longitudinal Motion: Linearization of equations of motion, Small disturbance theory, Longitudinal modes: Short period mode and Phugoid mode, Stability criteria and damping, Time response analysis

Lateral-Directional Motion: Rolling motion, Dutch roll mode, Spiral mode, Roll subsidence, Stability derivatives and their physical significance

Module 5: Stability Augmentation & Flight Control Systems (06 Hours)

Need for artificial stability, Stability Augmentation Systems (SAS), Fly-by-wire systems, Autopilot fundamentals, Feedback control basics

Suggested Textbooks

1. Flight Stability and Automatic Control by Nelson
2. Dynamics of Flight: Stability and Control by Etkin & Reid
3. Aircraft Control and Simulation by Stevens & Lewis
4. Introduction to Flight by Anderson