COURSE CODE	COURSE TITLE	L	T	P	C
1151AE112	AIRPLANE STABILITY AND CONTROL	3	0	0	3

Course Category:

Programme core

a. Preamble:

This course introduces about the stability and control of an aircraft. The stability and control are the two important pre-requisites of a safe flight. The six-degree-of-freedom differential equations of motion are introduced. Then the linearized perturbed state equations of motion are derived. Important topics in this course are: Longitudinal static and dynamics stability, stick fixed and free neutral points and static margin, lateral-directional static and dynamic stability, trim condition, longitudinal-lateral-directional coupling, control and maneuverability, stick fixed and free maneuverer points, stability and control derivatives and handling qualities and control response.

b. Prerequisite Courses:

- Linear system analysis and control
- Airplane performance

c. Related Courses:

- Aircraft Design
- Autopilot Design
- Flight Mechanics and Control Laboratory

d. Course Educational Objectives:

- To introduce the concepts of static and dynamic stability of airplanes in stick fixed and stick free conditions.
- To introduce the concept of control of airplanes under various operating conditions

e. Course Outcomes:

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Describe the concepts of stability and control and Determine static longitudinal stability criteria for a stable airplane	K2
CO2	Determine static longitudinal control derivatives, and Estimate the Maneuvering stability of an aircraft.	K3
CO3	Explain the static lateral and directional stability and control derivatives, and criteria for a stable airplane	K3
CO4	Determine the stability and control derivatives of an airplane	K3
CO5	Discuss the various dynamic instabilities of an aircraft motion	K2

f. Correlation of COs with POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**H**	**L**		**H**			**H**	**H**				
CO2	**H**	**L**		**H**			**H**	**H**				
CO3	**H**	**L**		**H**			**H**	**H**				
CO4	**H**	**L**		**H**			**H**	**H**				
CO5	**H**	**L**		**H**			**H**	**H**				

H- High; M-Medium; L-Low

g. Course Contents:

UNIT-I INDRODUCTION TO AIRPLANE STABILITY AND STATIC LONGITUDINAL STABILITY L-9

Degree of freedom of a system - Static and dynamic stability - Need for stability in an airplane - Purpose of controls - Inherently and marginally stable airplanes, Longitudinal Stability criterion – Contribution of wing and tail (Aft tail- Elevator & Forward tail –Canard) to pitching moments - Effect of fuselage and nacelles - Power effects - Stabilizer setting and center of gravity location. Control fixed neutral point. Stability margins.

UNIT-II STATIC LONGITUDINAL CONTROL AND MANAUVERING STABILITY L-9

Elevator power– Elevator to trim. Trim gradients. Effects of releasing the elevator. Hinge moment coefficients – Control forces to trim. Control free neutral point – Trim tabs. Aerodynamic balancing of control surfaces. Means of augmentation of control. Contribution of pitch damping to pitching moment of flight vehicle - Effect on trim and stability. Control deflections and control forces for trim in symmetric maneuvers and coordinated turns. Control deflection and force gradients. Control fixed and control free maneuver stability. Maneuver points. Maneuver margins.

UNIT-III STATIC LATERAL - DIRECTIONAL STABILITY AND CONTROL L-9

Dihedral effect - Coupling between rolling and yawing moment - Adverse yaw - Aileron power - Aileron reversal. Weather cocking effects – Rudder power. Lateral and directional stability-definition. Control surface deflections in steady sideslips, rolls and turns one engine inoperative conditions - Rudder lock.

UNIT-IV DYNAMIC EQUATIONS FOR FLIGHT VEHICLE: L-9

Equations of motion of a rigid body, Inertial forces and moments. Equations of motion of flight vehicles, aerodynamic forces and moments, Decoupling of longitudinal and lateral-directional equations. Linearization of equations, Aerodynamic stability and control derivatives, Relation to geometry, flight configuration, Effects of power, compressibility and flexibility.

UNIT-V DYNAMIC STABILITY ANALYSIS: L-9

Solutions to the stability quartic of the Linearized equations of motion. The principal modes. Phugoid, Short Period Dutch Roll and Spiral modes - Further approximations. Restricted degrees of motion. Solutions. Response to controls. Auto rotation and spin.

Total Periods: 45

h. Learning Resources

i. Text Books:

1. Robert C. Nelson, Flight Stability and Automatic Control, 2nd Edition, McGraw Hill, 1997
2. Courtland D. Perkins, Robert E. Hage, Airplane Performance, Stability and Control, 1st Edition, John Wiley, New York 1949

ii. References:

1. Bernard Etkin, Lloyd Duff Reid, Dynamics of Flight: Stability and Control, 3rd Edition, John Wiley, New York 1995
2. Warren F. Phillips., Mechanics of Flight, Second Edition, Wiley,2009
3. Thomas R. Yacht, Introduction to Aircraft Flight Mechanics: Performance, Static Stability, Dynamic Stability, Feedback Control and State-Space Foundations,2nd Revised Edition, AIAA Education Series, 2014
4. Bandu N. Pamadi, Performance, Stability, Dynamics, and Control of Airplanes, 2nd Edition, AIAA Education Series, 2004
5. Louis V. Schmidt, Introduction to Aircraft Flight Dynamics, 1st Edition, AIAA Education Series, 1998
6. Michael V. Cook., Flight Dynamics Principles: A Linear Systems Approach to Aircraft Stability and Control, 3rd edition, Butterworth-Heinemann
7. Nandan K. Sinha, N. Ananthkrishnan, Elementary Flight Dynamics with an Introduction to Bifurcation and Continuation Methods, 1st Edition, CRC Press, 2013
8. Roskam, J., Airplane Flight Dynamics and Automatic Flight Controls part I, DAR Corporation, 2001.