3/4 B.Tech. SIXTH SEMESTER

AE6T1 **Flight mechanics-II** **Credits: 3**

Lecture: 3 periods/week **Internal assessment: 30 marks**
Tutorial: 1 periods/week **Semester end examination: 70 marks** -

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Objectives:

1. Present trends in aircraft design towards augmented-stability and expanded flight envelopes call for an accurate description of the non-linear flight dynamic behaviour of the aircraft in order to properly design the Flight Control System (FCS). Hence the need to increase the knowledge about stability and control (S&C) as early as possible in the aircraft development process in order to be "First-Time-Right" with the FCS design architecture.
2. FCS design usually starts near the end of the conceptual design phase when the configuration has been tentatively frozen and experimental data for predicted aerodynamic characteristics are available.
3. Achieving these objectives will advance the state-of-the-art in computeraided concept design suitable for procuring economically amenable and ecologically friendly designs.

Learning Outcomes:

At the end of course the students will be able to:

1. Know the importance of static and dynamic stability and control with respect of aircraft axes.
2. Have generalized idea of aerodynamic conceptual design and design optimization of the aircraft models and components.
3. Estimate the aerodynamic force and moments coefficients of different aircrafts and models based on design and engine configuration.
4. Study the performance characteristics of aircrafts with respect to different operating conditions such as various mach numbers, different altitudes and various degrees of freedom of aircraft axes.
5. Learn the art of design of aircraft static models and working models flight control systems.
6. Think, create and innovate in the field of aeronautics.

Prerequisites:

Student should have the basic knowledge of aerodynamics-I and II, flight mechanics-I, introduction to aeronautical engineering, differential calculus and integral calculus and control systems and its applications in aeronautics.

UNIT- I

STATIC LONGITUDINAL STABILITY—STICK FIXED STEADY LEVEL FLIGHT

Forces and moments acting on an airplane in level flight- fuselage contribution- wing contribution- contribution of wing-fuselage combination-tail contributionneutral point-static margin-significance of tail volume ratio-C.G movementcondition for most forward location-elevator control power and elevator effectiveness

UNIT- II

STATIC LONGITUDINAL STABILITY—MANEUVERING FLIGHT AND STICK FREE STABILITY

Stick force gradients- effect of trim speed- role of trim tab- static and maneuversstability. Stick-free neutral and maneuvers points, stability margins- relation with stick force gradients. Aerodynamic and mass balancing of control surfaces, Control tabs- types, function, and construction

UNIT- III

LATERAL-DIRECTIONAL STATIC STABILITY AND TRIM

Lateral-directional motions, Yaw and side slip-aerodynamic forces and moments, coupling- aircraft side force, rolling moment and yawing moment, due to side slip, aileron and rudder- static aerodynamic derivatives.wing dihedral, sweep, position on fuselage-high angle of attack operations. Lateral-directional stability requirements, aileron, rudder control powers, adverse aileron yaw,

UNIT- IV

ESTIMATION OF AERODYNAMIC MOMENT DERIVATIVES OF AIRCRAFT

Derivatives of side force, rolling and yawing moments with respect to the angle of sideslip, rate of sideslip, roll rate, yaw rate, aileron, rudder deflections - dependence on vehicle geometry, flight configuration- estimation- the strip theory method. Lateral and directional stability, roll and yaw damping, aileron and rudder power, the cross derivatives, Relation between dimension-less and dimensional aerodynamic derivatives

UNIT- V

AIRCRAFT DYNAMIC STABILITY - LONGITUDINAL AND LATERAL - DIRECTIONAL

Review of solutions of second order ordinary differential equations. - Time constant, undamped natural frequency and damping ratio. Two degree of freedom constant speed approximation, constant angle of attack approximation,

Lateral directional equations. Determination of longitudinal and lateral stability from coefficients of characteristic equation- stability criteria, approximate roots, roll coupling, high angle of attack operation. Aircraft spin- entry, balance of forces in steady spin, recovery,

Learning resources

Text books:

1. Perkins, C.D., and Hage, R.G.,Airplane Performance, Stability and Control, ISBN-13: 978-71680468

2. Pamadi,B.N, Performance, Stability, Dynamics, and Control of Airplanes, 2nd Edition, AIAA Education Series
3. Nelson, R.C., Flight Stability and Automatic Control, 2ndEdn. Tata McGraw Hill, 2007, ISBN 0-07-066110-3

References:

1. Yechout, T.R. et al., Introduction to Aircraft Flight Mechanics, AIAA education Series, 2003, ISBN 156347-577-4.
2 Etkin, B. and Reid, L.D., Dynamics of Flight, 3rdEdn. John Wiley, 1998, ISBN 0-47103418-5.
3. Schmidt, L.V., Introduction to Aircraft Flight Dynamics, AIAA Education Series, 1998, ISBN A-56347-226-0.