COURSE CONTENT

FLIGHT DYNAMICS AND CONTROL								
II Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BAED13	Core	3	-	-	4	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Aerodynamics								

I. COURSE OVERVIEW:

Flight dynamics and control is the study of the performance, stability, and control of vehicles flying through the air or in outer space. It is concern with how the forces/moments are acting on the vehicle to determine its velocity and attitude with respect to time. This course is going to develop as an engineering science throughout succeeding generations of aircraft engineer to support increasing demands of aircraft stability and control and it now has a major role to play in the design of modern aircraft to ensure efficient, comfortable and safe flight. Modern aircraft control is ensured through automatic control systems known as autopilot. Their role is to increase safety, facilitate the pilot's task and improve flight qualities. The course will introduce modern aircraft stability and control and discuss some of its objectives and applications.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The fundamental principles of flight, controls, aerodynamic flows, forces and moments related to airfoils and aircrafts.
II. The mathematical formulations of aerodynamic performance, stability and the equations of motion related to flight dynamics of a rigid body in linear and non- linear motion.
III. The essential knowledge on coupled and decoupled equations of motion and the derivatives related to longitudinal and lateral dynamic stability of the air vehicles.
IV. The advance concept of automated control and numerical simulations of aircraft stability for the development of the modern future aircrafts and flight vehicles.

III. COURSE OUTCOMES:

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

CO 1 Make use of the principles of flight and governing aerodynamics laws for the control of aircraft motions forgetting the desired aircraft attitude characteristics.
CO 2 Model the range, endurance and stability of equilibrium under different types of motions for calculating the aerodynamic performance of an airplane.
CO 3 Analyze the concept of aircraft dynamics, equations of motion in linear and nonlinear motion for optimal flight conditions.
CO 4 Determine the linear equations off motion and derivatives for the coupled and decoupled motion in terms of stability axis system by using small perturbation theory for obtaining the state of dynamic stability.
CO 5 Develop the mathematical model for the dynamic and static stability and its derivatives by using computational numerical simulation for the different types of aircrafts.
CO 6 Examine the flight control system by using control theories and modern computational tools system for the conventional and automatic flight of the aircraft.

IV. COURSE CONTENT:

MODULE-I: INTRODUCTION (09)
Basic principles of flight; Flying control surfaces: Elevator, ailerons and rudder; Pilot's controls: The throttle, the control column, modes of flight; Basic principles governing aerodynamic flows: Introduction, continuity principle, Bernoulli's principle, laminar flows and boundary layers, turbulent flows, aerodynamics of airfoils and wings, slender body aerodynamics, wing-body interference, empennage aerodynamics, aerodynamics of complete aircraft, aerodynamic forces and moments.

MODULE-II: MECHANICS OF EQUILIBRIUM FLIGHT (09)
Introduction, speeds of equilibrium flight, basic aircraft performance, conditions for minimum drag, range and endurance estimation, trim, stability of equilibrium flight, longitudinal static stability, maneuverability, lateral stability and stability criteria, experimental determination of aircraft stability margins; Aircraft non- linear dynamics; Equations of motion, introduction, aircraft dynamics, aircraft motion in a two dimensional plane, moments of inertia, Euler's equations and the dynamics of rigid bodies, aircraft equations of motion, motion- induced aerodynamic forces and moments, non-linear dynamics of aircraft motion, trimmed equations of motion.

MODULE-III: SMALL PERTURBATIONS AND THE LINEARISED, DECOUPLED EQUATIONS OF MOTION (10)
Small perturbations and linearization; Linearizing the aerodynamic forces and moments: Stability derivative concept, direct formulation in the stability axis, decoupled equations of motion, decoupled equations of motion in terms of the stability axis aerodynamic derivatives, decoupled equations of motion in terms of the stability axis aerodynamic derivatives.

Non-dimensional longitudinal and lateral dynamics; Simplified state-space equations of longitudinal and lateral dynamics, simplified concise equations of longitudinal and lateral dynamics.

MODULE-IV: LONGITUDINAL AND LATERAL LINEAR STABILITY AND CONTROL (11)
Dynamic and static stability, modal description of aircraft dynamics and the stability, aircraft lift and drag estimation, estimating the longitudinal aerodynamic derivatives, estimating the lateral aerodynamic derivatives, aircraft dynamic response, numerical simulation and non-linear phenomenon longitudinal and lateral modal equations, methods of computing aircraft dynamic response, system block diagram representation, atmospheric disturbance, deterministic disturbances, principles of random atmospheric disturbance modeling, application to atmospheric turbulence modeling, aircraft non-linear dynamic response phenomenon.

MODULE-V: AIRCRAFT FLIGHT CONTROL (09)
Automatic flight control systems: An introduction, functions of a flight control system, integrated flight control system, flight control system design.

V. TEXT BOOKS:

1. Vepa, R., "Flight Dynamics, Simulation and Control: For Rigid and Flexible Aircraft", CRC Press, Taylor and Francis Group, 2015.

VI. REFERENCE BOOKS:

1. Wayne Durham, "Aircraft Flight Dynamics and Control", CRC Press, 2nd edition, 2013.
2. Robert F. Stengel "Flight Dynamics", CRC Press, 2nd edition, 2013.

VII. ELECTRONICS RESOURCES:

1. http://www.engin.umich.edu/aero/research/areas/controls
2. http://nptel.ac.in/courses/101106043/
3. http://www.princeton.edu/~stengel/MAE331Lectures.html

VIII. MATERIALS ONLINE

1. Course template.
2. Assignments.
3. Tutorial question bank.
4. Model question paper – I.
5. Model question paper – II.
6. Lecture notes.
7. Power point presentations.