INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

ATMOSPHERIC SPACE FLIGHT MECHANICS								
I Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
BAEE06	Elective	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	-	-	3	40	60	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Prerequisite: Flight Mechanics								

I. COURSE OVERVIEW:

This course is intended to study the automatic control of the flight vehicles through the air or in outer space. It concerns the forces and moments, that are acting on the air- vehicles to determine the position and attitude with respect to the time. It also develops as an engineering science throughout succeeding generations of aeronautical engineers to support increasing demands of autonomous aircraft navigation and control. It 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 in association with Fly-by-Wire, to increase safety, facilitate the pilot's task easier and improve flight qualities.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The fundamental theory of guidance and control systems of aircraft and also different augmentation systems used for aircraft and space vehicles
II. The different autopilot systems, flight path stabilization and Automatic Flare Control systems used for flight vehicles.
III. The modern automatic control systems like Fly-by-Wire, Fly-by-Optics systems and different flight control laws design using different algorithms.
IV. The advanced computational tools to design of navigation and guidance systems for automation of aircrafts, missiles, helicopters and space launch vehicles.

III. COURSE OUTCOMES:

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

CO 1 Formulate the equations of motion for aircraft in various flight phases under equilibrium conditions with appropriate assumptions.
CO 2 Define and derive the performance and stability attributes of aircraft in terms of the design variables for both jet and propeller propulsion units.
CO 3 Develop the competency to evaluate out the performance and stability characteristics of any given aircraft.
CO 4 Acquire knowledge on the basic concepts of satellite injection and satellite perturbations.
CO 5 Estimate the time and position of an object in various orbits.

IV. COURSE CONTENT:

MODULE-I: STATIC LONGITUDINAL STABILITY AND CONTROL (09)
Static equilibrium and stability – Pitch stability of conventional and canard aircraft – control fixed neutral point and static margin – effect of fuselage and running propellers on pitch stability – control surface hinge moment – control free neutral point – limit on forward CG travel – maneuver stability: Pull – up & level turn – control force and trim tabs – control force for maneuver – measurement of neutral point and maneuver point by flight tests.

MODULE-II: STATIC LATERAL, DIRECTIONAL STABILITY AND CONTROL (09)
Yaw and side slip, effect of wing sweep, wing dihedral and vertical tail on directional stability – rudder fixed and rudder free – yaw control – rudder sizing – pedal force - dihedral effect: contribution of various components- roll control.

MODULE-III: AIRCRAFT DYNAMICS (09)
Rigid body equations of motion - Axes systems and their significance – Euler angles – linearization of longitudinal equations – force and moment derivatives – short period and phugoid approximations – pure pitching motion.

Linearization of equations for lateral – directional motion – roll, spiral and Dutch roll approximations- Pure rolling- Pure yawing – Inertia coupling.

MODULE-IV: CHARACTERISTICS OF VARIOUS ORBITS (09)
Properties of elliptic, Parabolic and hyperbolic properties in terms of orbital elements – relations between position and time – Barker's theorem – Whittaker's theory – Sphere of influence

MODULE-V: SATELLITE INJECTION AND SATELLITE PERTURBATIONS (09)
General aspects of satellite injection – satellite orbit transfer – various cases – orbit deviations due to injection errors – special and general perturbations – Cowell's method and Enake's method – method of variations of orbital elements – general perturbations approach.

V. TEXT BOOKS:

1. Michael V. Cook, "Flight Dynamics Principles", 2nd Edition, Elsevier, 2007.
2. Nelson, RC, "Flight Stability & Automatic Control", 2nd Edition, McGraw-Hill, 2017.
3. Perkins CD & Hage, RE, "Airplane performance, stability and control", Wiley India Pvt Ltd, 2011.
4. Cornelisse, JW, Schoyer, HFR & Wakker, KF, "Rocket Propulsion and Space Dynamics", Pitman Publishing, 1979

VI. REFERENCE BOOKS:

1. Howard D. Curtis, "Orbital Mechanics for Engineering Students", 3rd Edition, Butterworth Heinemann, 2013.
2. Parker, ER, "Materials for Missiles and Spacecraft", McGraw Hill Book Co. Inc., 1982.

VII. ELECTRONICS RESOURCES:

1. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16...aircraft.../lecture-16
2. www.fsd.mw.tum.de/research/flight-control
3. nptel.ac.in/courses/101108056/

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