ENGINEERING ANALYSIS OF FLIGHT VEHICLES

II Semester: AE								
Course Code	Category	Hours /Week			Credits	Maximum Marks		
BAEC14	Core	L	T	P	C	CIA	SEE	Total
		3	-	-	3	30	70	100
Contact Classes:45	Tutorial Classes: Nil	Practical Classes: Nil				TotalClasses:45		

I. COURSE OVERVIEW:

Computational science and engineering involves the development and use of computational methods to simulate, predict, and understand important phenomena in this subject. The aerospace field is characterized by the complexity of the environments in which its systems operate — a complexity driven not only by extreme physical conditions, but by interactions with humans and by the need for robust performance in these settings. Many physical aerospace phenomena, such as turbulent combustion in gas turbine engines, transonic flow around transport aircraft, rarefied gas dynamics and ablation processes in atmospheric reentry, and countless more, that are essential to aerospace systems are both inaccessible in the laboratory and analytically intractable. Since the earliest days of computational fluid dynamics and computational mechanics, enormous efforts have been devoted to the development of predictive computational models of these complex processes.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The key factors affecting vehicles configuration.
II. The basic concepts of gravitational terms in the equations of motion.
III. The concepts of static stability, trim static performance.
IV. The dynamic performance of space craft with respect to non-rotating planets.

III. COURSE OUTCOMES:

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

CO1	**Identify** the factors affecting vehicles configuration for determining its effect on flight characteristics.	Understand
CO2	**Develop** the equation of motion for operation of vehicle relative to the ground and flight for rigid flight vehicles using Newton's laws.	Apply
CO3	**Construct** the equation of motion of launch vehicle and spacecraft for static performance, impact of stability and control for the rotating planet.	Apply
CO4	**Demonstrate** the perturbed longitudinal equation of motion for static and dynamic stability of rigid flight vehicles.	Analyze
CO5	**Inspect** the impact of stability and design of longitudinal control of flight vehicles using numerical integration method.	Analyze
CO6	**Examine** the gliding re-entry vehicle with respect to a rotating planet using equations of motion of launch vehicles for dynamic performance.	Understand

IV. SYLLABUS:

MODULE-I: THE MORPHOLOGY OF FLIGHT VEHICLES (08)

Introduction, Key factors affecting vehicles configuration, some representative flight vehicles.

MODULE-II: EQUATIONS OF MOTION FOR RIGID FLIGHT VEHICLES AND INTRODUCTION TO VEHICLE AERODYNAMICS (10)

Equations of Motion for Rigid Flight Vehicles: Definitions, Vector and Scalar realizations of Newton's second law, The tensor of inertia, Choice of vehicle axes, Operation of the vehicle relative to the ground; flight determination, Gravitational terms in the equations of motion, The state vector. Introduction to Vehicle Aerodynamics: Aerodynamics contributions to X, Y and M, dimensionless coefficients defined, equations of perturbed longitudinal motion.

MODULE-III: AIRCRAFT DYNAMICS AND STATIC STABILITY, TRIM STATIC PERFORMANCE AND RELATED SUBJECTS (10)

Aircraft Dynamics: Equations of Motion of Aircraft including forces and moments of control surfaces, Dynamics of control surfaces.

Static Stability, Trim Static Performance and Related Subjects: Impact of stability requirements on design and longitudinal control, Static performance.

MODULE-IV: DYNAMIC PERFORMANCE OF SPACECRAFT WITH RESPECT TONON-ROTATING PLANETS (09)

Introduction, Numerical integration of ordinary differential equations, Simplified treatment of boost from a non-rotating planet, An elementary look at staging, Equations of boost from a rotating planet.

MODULE-V: DYNAMIC PERFORMANCE OF SPACECRAFT AND DYNAMICPERFORMANCE-ATMOSPHERICENTRY (08)

Dynamic Performance of Spacecraft: Equations of Motion of Launch Vehicles with respect to a rotating planet, Motion of Spacecraft with respect to a rotating planet. Dynamic Performance-Atmospheric Entry: Equation of motion, Approximate analysis of gliding entry into a planetary atmosphere.

V. TEXT BOOKS:

1. Holt Ashley, "Engineering Analysis of Flight Vehicles", Dover Publications, 1992.

VI. REFERENCE BOOKS:

1. J.D. Anderson, "Fundamentals of Aerodynamics", McGraw-Hill, 5^{th} Edition, 2001.
2. J.J.Bertin, R.M Cummings, "Aerodynamics for Engineers", Pearson, 5^{th} Edition, 2009.
3. Argyris G.Panaras, "Aerodynamic Principles of Flight Vehicles", AIAA Inc, 1^{st} Edition, 2012.

VII. WEB REFERENCES:

1. https://mitpress.mit.edu/books/flight-vehicle-aerodynamics
2. https://www.edx.org/course/flight-vehicle-aerodynamics-mitx-16-110x-0
3. https://www.mooc-list.com/course/16110x-flight-vehicle-aerodynamics-edx?static=true

VIII. E-TEXT BOOKS:

1. http://www.freeengineeringbooks.com/AeroSpace/Aerodynamics-Books.php
2. http://www.booksamillion.com/p/Flight-Vehicle-Aerodynamics/Mark-Drela/Q685536838
3. https://www.overdrive.com/media/1553992/flight-vehicle-aerodynamics