ATMOSPHERIC RE ENTRY VEHICLES

II Semester: AE								
Course Code	**Category**	**Hours /Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BAEC19	**Elective**	3	-	-	3	30	70	100
Contact Classes:45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes:45**		

I. COURSE OVERVIEW:

This course deals with fundamental aspects of an anatomy of re-entry module and the current trends in airframe design. It includes the evolution of the re-entry module in space industry, aerodynamics and performance of the module with their applications. It compares and contrasts various thrust vector control mechanisms of different types of atmospheric re-entry. It discusses various materials and its properties that are used for manufacturing different parts of re-entry module. This course enriches the knowledge of connection between theoretical and practical methods for performing re-entry in atmosphere.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The basic mechanism of reentry vehicle.
II. Aerodynamic principles and flight dynamics.
III. The equations of motion for reentry vehicles.
IV. The properties of different materials that are used in industries for manufacturing various components of an aircraft and spacecraft.

III. COURSE OUTCOMES:

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

CO 1	**Understand** the theoretical knowledge behind the design and development of re-entry module and distinguishes them based on the mission requirements.	**Understand**
CO 2	**Apply** Newton's law of motion to determine the governing equations for interpreting the physics of flow over a re-entry module.	**Apply**
CO 3	**Identify and obtain** values of performance parameters of a re-entry module based on the aerodynamic forces and moments acting on the body at different practical scenarios.	**Apply**
CO 4	**Describe** the properties of an international standard atmosphere for identifying the suitable re-entry module to fly for different practical scenarios such as conventional transport, human space flight missions etc.	**Apply**
CO 5	**Explain** the different types of stability techniques and their usage in real world applications by understanding its limitations and safety measures.	**Apply**
CO 6	**Explain** different material properties and their usage in different segments of re-entry module	**Apply**

IV. COURSE SYLLABUS:

MODULE-I: OVERVIEW AND INTRODUCTION (08)

Classical point mass mechanics, mechanics of rigid bodies, topography and gravitation, the geodetic frame of reference, the terrestrial field of gravitation, models of atmosphere, main parameters and hypotheses, the isothermal exponential model, standard models of earth's atmosphere, martian models.

MODULE-II: AERODYNAMICS (10)

Aerodynamic coefficients, modes off low, continuous mode, rare field mode, qualities of flight, characteristics of a family of sphere cones, planetary entry capsule.

MODULE-III: SPECIAL TREATMENT FOR REENTRY VEHICLE (10)

Inertial Models: Moments of inertia, cg off set and principal axis misalignment; Changing of Reference Frame: Direction cosine matrices, Euler angles, representations with four parameters.

Exo atmospheric phase: Movement of the center of mass, movement around mass center.

MODULE-IV: EQUATIONS OF MOTION (09)

Six degree-of-freedom reentry: General equations of motion, solutions of general equations, zero angle of attacker entry; Allen‟s reentry results, influence of ballistic coefficient and flight path angle, influence of range; Decay of initial incidence: Zero spinrate, nonzero spin.

MODULE-V: FLIGHT DYNAMICS OF RE ENTRY VEHICLE (08)

End of the convergence of the incidence: Linear equations, instantaneous angular movement, real angular motion; Roll-lock-in Phenomenon: Association of aerodynamic asymmetry and cg offset, isolated center of gravity, isolated principal axis misalignment, combined cg offset and principal axis misalignment, instabilities: static instabilities, dynamic instabilities; Reentry errors: Zero angle-of-attack dispersions, non zero angle of attack.

V. TEXT BOOKS:

1. Patrick Gallais, “Atmospheric Re-Entry Vehicle Mechanics”, Springer,1st Edition, 2007.
2. W.Hankey, “Re-Entry Aerodynamics”, AIAA Education series,1st Edition,1988.
3. Frank J. Regan “Dynamics of Atmospheric Re-Entry” American Institute of Astronautics and Aeronautics Publications, 1st Edition, 1993.

VI. REFERENCE BOOKS:

1. Peter Fortescue, “Spacecraft Systems Engineering”, Wiley, 4th Edition, 1992.
2. Vladimir A.Chobotov, “Orbital Mechanics”, AIAA Education series, 3rd Edition, 2002.

VII. WEB REFERENCES:

1. http://spacecraft.ssl.umd.edu/academics/791S04/791S04.040302.text.pdf

VIII. E-TEXT BOOKS:

1. http://download.e-bookshelf.de/download/0000/0122/72/L-G-0000012272-0002345666.pdf
2. http://www.spaceatdia.org/uploads/mariano/ss1/Spacecraft%20Systems%20Engineering.pdf