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

COURSE CONTENT

HYPERSONIC AERODYNAMICS								
VII Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
AAED46	**Elective**	3	0	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: High Speed Aerodynamics, Gas Dynamics								

I. COURSE OVERVIEW:

Space dynamics is a branch of aerospace engineering that focuses on the motion and behavior of objects in space. It encompasses the study of celestial bodies, artificial satellites, and spacecraft, examining their trajectories, orbits, and interactions. This field seeks to understand the gravitational forces, orbital mechanics, and propulsion systems governing the movement of objects in the cosmos. Space dynamics plays a crucial role in mission planning, satellite deployment, and space exploration, providing the analytical tools necessary for accurate predictions of spacecraft trajectories and maneuvers. Ultimately, a mastery of space dynamics is essential for the successful design, navigation, and control of vehicles operating in the vast and challenging environment of outer space.

II. COURSES OBJECTIVES:

The students will try to learn:

I. The behaviors and challenges that arise when vehicles or objects travel at hypersonic speeds (Mach 5 and above). Concept of microelectronic devices along with the revolution and applications, with the emphasis on digital data buses.
II. Develop materials and designs for efficient thermal protection systems that can withstand high temperatures.
III. Enhance their overall performance. This involves minimizing drag, maximizing lift, and ensuring stability throughout the entire flight regime.
IV. Explore and develop propulsion technologies that are specifically tailored for hypersonic speeds.

III. COURSE OUTCOMES:

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

CO1 Develop a deep understanding of the fundamental principles governing aerodynamic phenomena at hypersonic speeds, including shockwave interactions, boundary layer transition, and thermal effects on vehicle surfaces.
CO2 Analysis and Prediction of Hypersonic Flow Patterns
CO3 Design and optimization of Hypersonic Vehicles
CO4 Develop the thermal Protection Systems and Material Selection
CO5 Design propulsion Systems for Hypersonic Travel
CO6 Explore the principles and technologies behind propulsion systems suitable for hypersonic speeds.

IV. COURSE CONTENT:

MODULE- I: INTRODUCTION TO HYPERSONIC (09)

Definition of hypersonic speeds, Distinction between transonic, supersonic, and hypersonic flows, Overview of hypersonic vehicles and their applications.

MODULE – II: BASIC FLUID MECHANICS REVIEW (09)

Navier-Stokes equations, Reynolds number and Mach number, Shock waves and expansion waves.

MODULE – III: THERMODYNAMICS AND GAS DYNAMICS (09)

Conservation laws for mass, energy, and momentum

Perfect and real gases at high temperatures, Stagnation properties and isentropic flow.

MODULE – IV: HYPERSONIC FLOW REGIMES (10)

Definition of hypersonic flow regimes (Mach 5 and above), Differences between low and high Reynolds number flows, Characteristics of hypersonic boundary layers.

MODULE- V: SHOCK WAVE THEORY (11)

Normal and oblique shock waves, Shock polar and Mach angle, Interaction of shock waves with surfaces, Hypersonic Wind Tunnel Testing Facilities and techniques for hypersonic testing, Challenges in simulating hypersonic conditions, Instrumentation for measuring hypersonic flow parameters.

V. TEXT BOOKS:

1. Wallace D. Hayes and Ronald F. Probstein , "Introduction to Hypersonic Flow"
2. William H. Heiser and David T. Pratt "Hypersonic Airbreathing Propulsion"

VI. REFERENCE BOOKS:

1. John D. Anderson Jr, "Hypersonic and High-Temperature Gas Dynamics"
2. Dinshaw S. Ruggeri, "Introduction to Hypersonic Flow"

VII. ELECTRONICS RESOURCES:

1. https://archive.nptel.ac.in/courses/101/103/101103003/

VIII. MATERIALS ONLINE

1. Course template
2. Tutorial question bank
3. Tech talk topics
4. Open end experiments
5. Definitions and terminology
6. Assignments
7. Model question paper – I
8. Model question paper - II
9. Lecture notes
10. E-learning readiness videos (ELRV)
11. Power point presentation