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

COURSE CONTENT

MISSILE AERODYNAMICS								
III Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BAEE26	**Elective**	3	-	-	3	40	60	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Prerequisite: Aerodynamics								

I. COURSE OVERVIEW:

The Missile Aerodynamics course is intended for the aerospace professional seeking expert instruction in the fundamentals of missile aerodynamics as applied to airframe design, analysis and test. The course provides students with a focused training experience in the aerodynamics of tactical missiles, ballistic missiles, launch vehicles, sounding rockets and projectiles. Participants will learn about vehicle 6-DOF aerodynamic force and moment models, airframe component air loads, atmospheric models, and mass property models. The course also includes a consideration of the unique aspects of projectile aerodynamics with particular emphasis on vehicle static, dynamic, and gyroscopic stability.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The fundamental aspects of aerodynamic characteristics and performance of various missiles.
II. The lateral, directional stability, control and their maneuverability.
III. The various design criteria and their modeling

III. COURSE OUTCOMES:

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

CO 1 Classify various missiles and their control for the suitable selection in real world applications.
CO 2 Describe the aerodynamic characteristics of airframe components for different missile configurations
CO 3 Calculate the performance of various missile configurations for different operational envelops
CO 4 Compare the longitudinal stability of various missiles for forward and rear control
CO 5 Choose the appropriate wing, body and tail configuration for better directional stability
CO 6 Apply the formation of induced roll and their control for improving lateral stability of missile

IV. COURSE CONTENT:

MODULE-I: INTRODUCTION (09)
Theory of bodies of revolution; Lift and moment of slender bodies of revolution; Planar W-B interference; Classes of missiles, types of design and control; Wing, canard, tail, tailless control; Dorsal, jet control, mono-wing, triform, and cruciform.

MODULE-II: AERODYNAMIC CHARACTERISTICS OF AIRFRAME COMPONENTS & MISSILE PERFORMANCE (09)
Forebody: Conical, Ogival, hemi-spherical, etc.; Midsection: Boat-tail; Characteristics of bodies of revolution; Aerodynamics of airfoil, aspect-ratio, wing plan form; Aerodynamic control: Wing, canard and tail; Missile performance: Introduction; Drag: Friction, pressure, interference, induced and boat tail drag; Boost glide trajectory: graphical and iterative method; Long range cruise trajectory; Maximum speed, rate of climb, time to climb, stall speed, maximum range; Long range ballistic trajectory: powered and un powered flight and design consideration.

MODULE-III: LONGITUDINAL STABILITY AND CONTROL, MANEUVERING FLIGHT (09)
Introduction, two-degree of freedom analysis, complete missile aerodynamics: static stability margin, load factor capability for forward control and rear control.

Flat turn: Cruciform, trim form, pull-ups; Relation between maneuverability and load factor; Stability margin.

MODULE-IV: DIRECTIONAL & LATERAL STABILITY AND CONTROL (09)
Introduction; Cruciform configuration: wing, body and tail contribution; Directional control; Introduction to lateral stability and control; Induced roll: Cruciform, lateral control cruciform, special design consideration, damping in roll, induced roll, mono wing, lateral control, mono wing.

MODULE-V: AIRLOADS: DESIGN CRITERIA (09)
Forward control; Rear control; Component air loads: Body, aerodynamic surfaces; Component load distribution: Body and lifting surfaces; Aerodynamic hinge moments and aerodynamic heating.

V. TEXT BOOKS:

1. S.S.Chin, “Missile Configuration Design”, Mc Graw Hill, 1st edition, 1960.
2. Jack N. Neilson, “Missile Aerodynamics”, Mc Graw Hill, 1st edition, 1960.

VI. REFERENCE BOOKS:

1. M.J. Hemsch, J.N. Nielsen, “Tactical Missile Aerodynamics”, AIAA, 2006.
2. J. H. Blacklock, “Automatic Control of Aircraft and Missiles”, John Wiley & Sons, 2nd edition, 1991.

VII. ELECTRONICS RESOURCES:

1. http://techdigest.jhuapl.edu/views/pdfs/V04_N3_1983/V4_N3_1983_Cronvich.pdf
2. http://www.dtic.mil/dtic/tr/fulltext/u2/a217480.pdf
3. http://ntrs.nasa.gov/archive/nasa/casi;ntrs.nasa.gov/19880020389; pdf

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.