

MISSILE AERODYNAMICS

III Semester: AE																													
Course Code	Category	Hours /Week			Credits	Maximum Marks																							
BAEC26	Elective	L	T	P	C	CIA	SEE	Total																					
		3	-	-	3	30	70	100																					
Contact Classes:45		Tutorial Classes: Nil		Practical Classes: Nil		Total Classes: 45																							
<p>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 airloads, 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.</p> <p>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.</p> <p>III. COURSE OUTCOMES: After successful completion of the course, students will be able to:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">CO</th> <th style="width: 70%;">Outcome</th> <th style="width: 20%;">Action</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">CO 1</td> <td>Classify various missiles and their control for the suitable selection in real world applications.</td> <td style="text-align: center;">Understand</td> </tr> <tr> <td style="text-align: center;">CO 2</td> <td>Describe the aerodynamic characteristics of airframe components for different missile configurations</td> <td style="text-align: center;">Understand</td> </tr> <tr> <td style="text-align: center;">CO 3</td> <td>Calculate the performance of various missile configurations for different operational envelopes</td> <td style="text-align: center;">Apply</td> </tr> <tr> <td style="text-align: center;">CO 4</td> <td>Compare the longitudinal stability of various missiles for forward and rear control</td> <td style="text-align: center;">Analyze</td> </tr> <tr> <td style="text-align: center;">CO 5</td> <td>Choose the appropriate wing, body and tail configuration for better directional stability</td> <td style="text-align: center;">Apply</td> </tr> <tr> <td style="text-align: center;">CO 6</td> <td>Apply the formation of induced roll and their control for improving lateral stability of missile</td> <td style="text-align: center;">Apply</td> </tr> </tbody> </table> <p>IV. SYLLABUS: MODULE-I: INTRODUCTION (08) 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.</p> <p>MODULE-II: AERODYNAMIC CHARACTERISTICS OF AIRFRAME COMPONENTS & MISSILE PERFORMANCE (10) 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</p>									CO	Outcome	Action	CO 1	Classify various missiles and their control for the suitable selection in real world applications.	Understand	CO 2	Describe the aerodynamic characteristics of airframe components for different missile configurations	Understand	CO 3	Calculate the performance of various missile configurations for different operational envelopes	Apply	CO 4	Compare the longitudinal stability of various missiles for forward and rear control	Analyze	CO 5	Choose the appropriate wing, body and tail configuration for better directional stability	Apply	CO 6	Apply the formation of induced roll and their control for improving lateral stability of missile	Apply
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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 unpowered flight and design consideration.

MODULE-III: LONGITUDINAL STABILITY AND CONTROL, MANEUVERING FLIGHT (10)

Introduction, two-degree of freedom analysis, complete missile aerodynamics: static stability margin, load factor capability for forward control and rear control.

Flat turn: Cruciform, triform, 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 (08)

Forward control; Rear control; Component air loads: Body, aero dynamic surfaces; Component load distribution: Body and lifting surfaces; Aero dynamic hinge moments and aerodynamic heating.

V. TEXT BOOKS:

1. S.S.Chin, "Missile Configuration Design", McGraw Hill, 1st Edition, 1960.
2. Jack N.Neilson, "Missile Aerodynamics", McGraw Hill, 1st Edition, 1960.

VI. REFERENCE BOOKS:

1. M.J.Hensch, 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. WEBREFERENCES:

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. E-TEXTBOOKS:

1. <http://www.abebooks.com/Missile-Configuration-Design-CHIN-S-S/9847235911/bd>
2. https://aerocastle.files.wordpress.com/2012/04/missile_configuration_desig.pdf
3. <http://www.worldcat.org/title/missile-configuration-design/oclc/602683910>
4. <https://www.waterstonesmarketplace.com/Missile-aerodynamics-Jack-Norman-Nielsen/book/4396415>