

MISSILE AERODYNAMICS

III Semester: AE								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
BAEB22	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 course should enable the students to: I. Explain the aerodynamic characteristics in missile. II. Discuss the lateral and directional stability, control and maneuvering flight. III. Understand the aerodynamic loads in missile.</p>								
<p>III. COURSE OUTCOMES: After successful completion of the course, students will be able to:</p>								
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	
<p>IV. SYLLABUS:</p>								
UNIT-I	INTRODUCTION						Classes: 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.								

UNIT-II	AERODYNAMIC CHARACTERISTICS OF AIRFRAME COMPONENTS & MISSILE PERFORMANCE	Classes: 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 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.		
UNIT-III	LONGITUDINAL STABILITY AND CONTROL, MANEUVERING FLIGHT	Classes: 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.		
UNIT-IV	DIRECTIONAL & LATERAL STABILITY AND CONTROL	Classes: 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.		
UNIT-V	AIR LOADS: DESIGN CRITERIA	Classes: 08
Forward control; Rear control; Component air loads: Body, aerodynamic surfaces; Component load distribution: Body and lifting surfaces; Aerodynamic hinge moments and aerodynamic heating.		
Text Books :		
<ol style="list-style-type: none"> 1. S. S. Chin, "Missile Configuration Design", McGraw Hill, 1st Edition, 1960. 2. Jack N. Neilson, "Missile Aerodynamics", McGraw Hill, 1st Edition, 1960. 		
Reference Books:		
<ol style="list-style-type: none"> 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. 		
Web References:		
<ol style="list-style-type: none"> 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 		
E-Text Books:		
<ol style="list-style-type: none"> 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 		