



WHITE EAGLE
AEROSPACE



Fundamentals of 6-DOF Aerodynamics Models

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Course Description

Fundamentals of 6-DOF Aerodynamics Models (FAM) offers an in-depth training experience in the formal and rigorous synthesis of professional-grade 6-DOF force and moment aerodynamics models used in 6-DOF trajectory flight simulations. Pertinent applications include tactical missiles, sounding rockets, launch vehicles, and projectiles.

The Body Axis and Maneuver Axis Coordinate Systems are discussed in detail. Airframe aerodynamic attitude is defined in terms of total angle-of-attack and aerodynamic roll position. Body Axis and Maneuver Axis steering controls are defined and their use in the aero modeling process is explained.

The subject of mutual aerodynamic interference is clearly delineated as is the closely allied principles of aerodynamic coupling. Roll-dependent basic stability aerodynamic force and moment characteristics are discussed from the standpoints of data periodicity and recurrence.

The attributes of a high-fidelity 6-DOF Aerodynamics Model architecture for body-wing-tail and body-tail configurations are highlighted. The basic stability and control effectiveness components of the aero model are thoroughly discussed as is the topic of a companion, high-quality aero uncertainties model.

Single Panel, Dual Panel, and Multi-Panel Modeling Schemes are presented and thoroughly examined. The ability of each scheme to capture important panel-panel interference effects is characterized.

Key Course Topics

- Missile Coordinate Systems
- Body Axis System
- Aero Forces and Moments
- Maneuver Axis System
- Steering Controls Schemes
- Mutual Aerodynamic Interference
- Aerodynamic Coupling
- 6-DOF Aero Models
- Aerodynamic Modeling
- Wind Tunnels
- Aerodynamic Architecture
- Basic Stability
- Control Effectiveness
- Aero Uncertainties
- Aero Data Tables
- Body-Wing-Tail
- Body-Canard-Tail
- Body Alone
- Combined Tail
- Panel-Panel Interference
- Roll-Dependent Aerodynamics
- Body-Tail





Course Outline

Fundamentals of 6-DOF Aerodynamics Models (FAM) is a first course in the discipline of 6-DOF aerodynamic force and moment modeling. With an emphasis on accurately capturing aerodynamic coupling effects for vehicles with control surfaces arranged in cruciform, powerful, but little-known, aerodynamic modeling schemes are presented. Real-world applications include tactical missiles, sounding rockets, launch vehicles, and projectiles.

Fundamentals of 6-DOF Aerodynamic Models Module Overview

Day	Module	Lecture Title	Key Topics
1	1	Coordinate Systems	Body Axis system, Maneuver Axis System, Body Axis Controls Scheme, Maneuver Axis Controls Scheme, Aerodynamic Attitudes.
	2	Mutual Aerodynamic Interference	Panel-due-to-body, body-due-to-panel, panel-due-to-panel, body upwash, panel carryover, body and panel vortices
	3	Aerodynamic Coupling	Cruciform control surface group. Intended aero effects. Aero Coupling effects. Byproduct aero effects.
2	4	Roll-Dependent Aerodynamic Characteristics	Control panel arrangement. Periodicity interval. Recurrence interval, basic stability aerodynamics.
	5	6-DOF Aerodynamics Models	Modeling architecture. Modeling structure. Basic stability. Control effectiveness. Panel-panel interference.
	6	Single Panel Modeling Scheme	Individual control panel deflection. Aero force and moment build-up equations. 6-DOF body axis aero data.
3	7	Dual Panel Modeling Scheme	Pitch, yaw, and roll body axis controls. Aero force and moment build-up equations. 6-DOF body axis aero data.
	8	Multi-Panel Modeling Scheme	Elevator, rudder, and aileron maneuver axis controls. Aero force and moment build-up equations. 6-DOF maneuver axis aero data.
	9	6-DOF Aerodynamics Database	Wind tunnel testing. Computational Fluid Dynamics. Aero force and moment data table generation. Aero data uncertainties.