

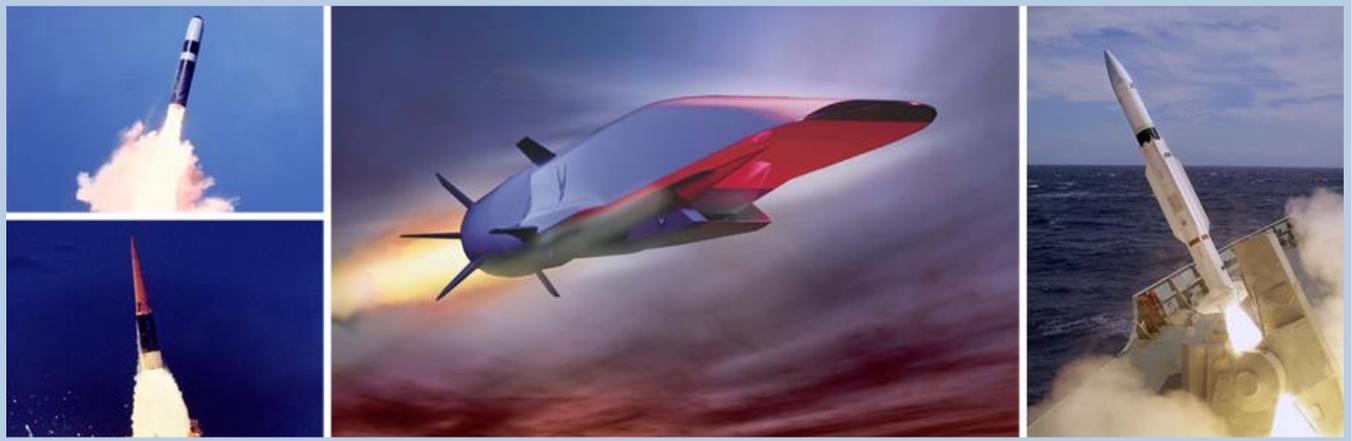


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AEROSPACE



# Fundamentals of Hypersonics

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# Course Description

**The Fundamentals of Hypersonics (FOH) short course provides a comprehensive training experience in the basic principles, technologies and methodologies in the multi-disciplined realm of hypersonic flight.**

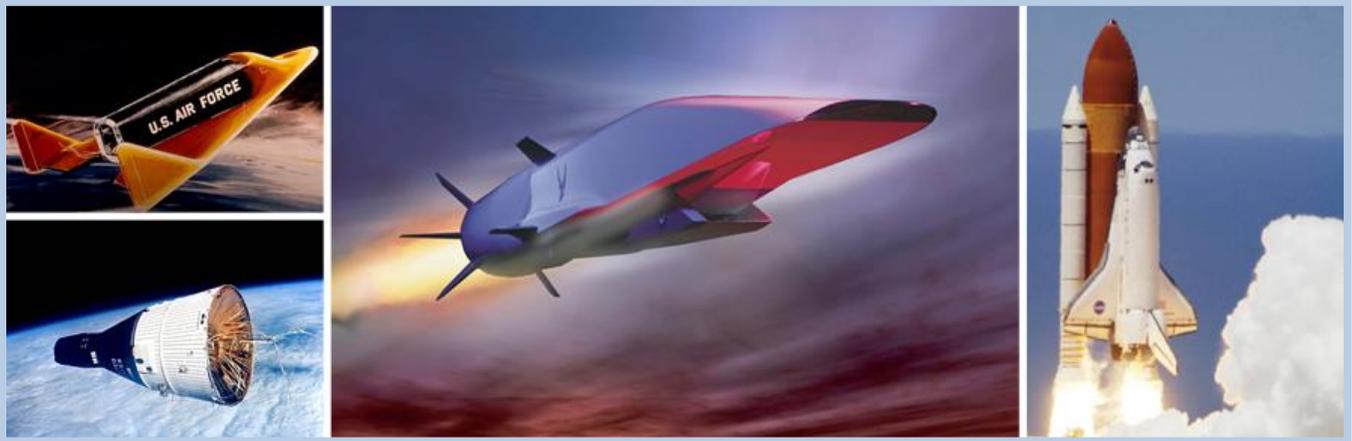
Key technical topics covered in this course include: hypersonic aerodynamics, hypersonic flow physics, high temperature gas dynamics, aerodynamic heating, plasma effects, aeroacoustics, and flight vehicle force and moment characteristics. However, course material extends beyond basic hypersonics, covering a myriad of other multi-disciplinary topics that are intimately related to hypersonic flight, including: airbreathing propulsion systems, thermal protection systems, aerothermoelastic effects, planetary entry, stage separation and atmospheric models.

Participants will acquire a sound understanding of hypersonic aerophysics and the effects of the hypersonic flight environment on vehicle loads and performance, including a consideration of both continuum flow and rarefied flow aerodynamic effects. They will understand the basics of hypersonic air breathing propulsion and the importance of having an accurate aero-propulsion force accounting system. Finally, participants will come to appreciate the extensive and impressive history of hypersonic flight and its influence on both current day and projected hypersonic programs.

## Key Course Topics

- Hypersonic Gas Dynamics
- Aerodynamic Heating
- Aeroacoustic Effects
- Plasma Effects
- Airbreathing Propulsion
- Continuum Flow Aerodynamics
- Transitional Flow Aerodynamics
- Rarefied Flow Aerodynamics
- Equilibrium Effects
- Non-Equilibrium Effects
- Viscous Interactions
- Thermal Protection Systems
- Hypersonic Vehicle Design
- Waverider Aerodynamics
- Planetary Entry Vehicles
- Atmospheric Models
- Jet Interaction Effects
- Force Accounting Systems
- Aerothermoelasticity
- Stage Separation
- Rail Gun Technology
- Historical Flight Programs





# Course Outline

**Fundamentals of Hypersonics (FOH) is intended for those seeking a comprehensive training experience in the basic principles, technologies, and methodologies of hypersonics. Course material also explores aerodynamics-related topics that are intimately connected to hypersonic flight test and flight research operations.**

## Fundamentals of Hypersonics Module Overview

Day	Module	Lecture Title	Key Topics
1	1	Hypersonic Gas Dynamics	Gas models, temperature effects, chemical reactions, continuum flow, free molecule flow.
	2	Hypersonic Aerodynamics	Newtonian theory, pressure methods, skin friction methods, lift and drag, rarefied flows.
2	3	Hypersonic Aerothermodynamics	Stagnation heating, heat transfer modes, body shape effects, thermal protection, plasma.
	4	Boundary Layer Transition	Mach number effects. Reynolds number effects. Turbulence. Body shape effects. Transition.
	5	Aeroacoustic Phenomena	Flowfield effects, body shape effects, sound pressure level, probability density function.
3	6	Hypersonic Body Alone Airframes	Cone aerodynamics. Nose-Cylindr-Flare. Rocket motor plume effects. Moldline shape effects on nose wave drag. Reentry vehicle aerodynamics.
	7	Hypersonic Lifting Airframes	Lift-to-drag ratio of flat plates. Compression lift. Delta wing airframes. Attaining high lift-to-drag ratios. Elliptic cross section bodies with and without wings.
	8	Waverider Aerodynamics	Wedge waverider, conical waverider, lift-to-drag ratio, aero-gravity assist maneuver
4	9	Air-Breathing Propulsion	Turbojets, ramjets, scramjets, energy food chain, hypersonic cruiser, transatmospheric vehicles.
	10	Jet Interaction Effects	Flow phenomenology, amplification factors, key parameters, similitude factors, aero modeling.

