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AEROSPACE

Aerodynamics For Engineers

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Course Description

The Aerodynamics For Engineers (AFE) short course provides a comprehensive training experience in fundamental aerodynamics applicable to flight ranging from subsonic to hypersonic speeds. The course arms participants with a sound understanding of a broad spectrum of fundamental aerodynamics concepts and phenomena.

Subject matter ranges from low-speed, incompressible flows to high-speed flows where compressibility effects such as shock waves are important. Participants will learn how aerodynamic forces and moments are generated for any flight vehicle at any speed and any aerodynamic attitude.

Course material explores the viscous boundary layer, turbulence, and flow separation and how these phenomena critically affect airfoil lift and drag characteristics. Participants will come to understand the significance of Mach number, Reynolds number, and the principle of Dynamic Similarity and their key influences in the field of wind tunnel testing.

Participants will learn the basics of aerodynamic heating and why thermal effects drive the design of high-speed flight vehicles such as aircraft, missiles and entry vehicles. They will also gain a working knowledge of rudimentary thermodynamics, airbreathing propulsion, and atmospheric entry concepts. Finally, attendees will use simple equational tools to make first-order, real-world aerodynamic calculations.

Key Course Topics

- The Atmosphere
- Fluid Properties
- Aero Forces and Moments
- Incompressible Flow
- The Boundary Layer
- Flow Separation
- Airfoils and Wings
- Aerodynamic Lift
- Aerodynamic Drag
- Wind Tunnels
- Compressible Flow
- Conservation Laws
- Mach Number
- Shock Waves
- Expansion Waves
- Airbreathing Propulsion
- Aerodynamic Heating
- Reynolds Number
- Planetary Entry
- Knudsen Number
- Hydrostatic Equation
- Historical Flight Programs

Course Outline

Aerodynamics For Engineers (AFE) is intended for those seeking a broad technical grounding in the fundamentals of aerodynamics. Principles of low-speed, incompressible flows and high-speed, compressible flows are treated. This course is ideal for those who are not professional aerodynamicists, but who need some basic technical training in the field of aerodynamics.

Aerodynamics For Engineers Module Overview

Day	Module	Lecture Title	Key Topics
1	1	Basic Aerodynamics Principles	Gases, liquids, pressure, temperature, density, specific volume, Perfect Gas Law, atmospheric properties.
	2	Incompressible Flow	Steady flow, conservation of mass, velocity, area, conservation of momentum, airspeed measurement.
2	3	Viscous Flow	Fluid viscosity, shear stress, boundary layer, laminar flow, turbulent flow, Reynolds number, flow separation.
	4	Airfoils and Wings	Lift, drag, pitching moment, sectional characteristics, lift curve slope, stall, aspect ratio, wing vortex, induced drag.
3	5	Thermodynamics Principles	Internal energy, entropy, enthalpy, specific heats, conservation of energy, isentropic flow.
	6	Compressible Flow	Compressible flow regimes, Mach number, speed of sound, shock waves, converging-diverging ducts.
	7	Supersonic Aerodynamics	Compressibility, Critical Mach number, drag divergence, wave drag, Mach angle, wing sweep effects.
4	8	Hypersonic Aerodynamics	Newtonian theory, Mach number independence, viscous interaction, Knudsen number, hypersonic aircraft.
	9	Air-Breathing Propulsion	Jet propulsion principle, military thrust, afterburner thrust, turbojet, turbofan, ramjet, scramjet engines.
	10	Atmospheric Entry	Equations of motion, altitude-velocity map, entry corridor, ballistic entry, gliding entry, and aerodynamic heating.