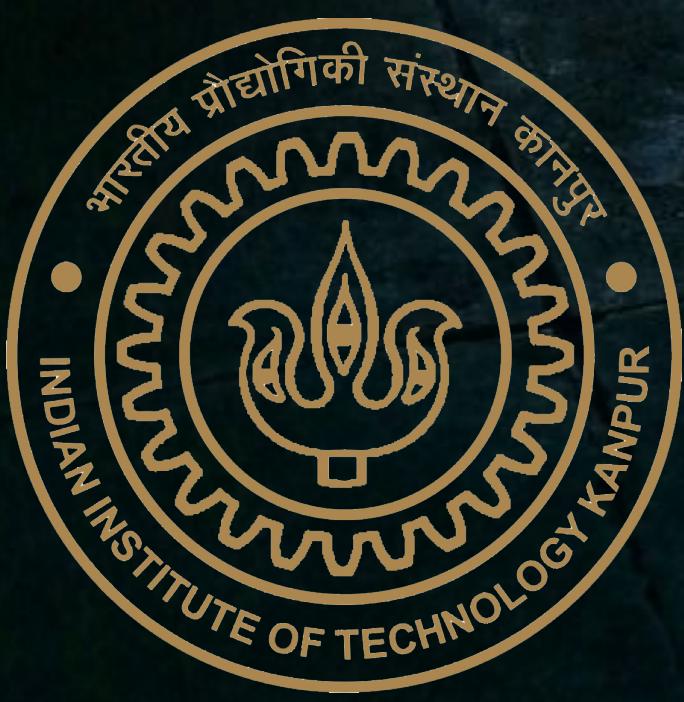


DEPARTMENT OF AEROSPACE ENGINEERING  
INDIAN INSTITUTE OF TECHNOLOGY KANPUR  
PLACEMENT BROCHURE  
**2020-2021**



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# About us

Established in 1964, the department of Aerospace Engineering at IITK is one of the prominent centers for advanced flight research and development across the lengths and breadths of the country. Not only did the department contribute to the aerospace industry but has also endorsed projects to strengthen the air superiority of the nation. Moreover, the department is engaged in Engineering Science instruction, in-flight laboratory work, aerodynamic testing, indigenous design and fabrication of advanced facilities and instruments. The department specializes in Aerodynamics, Flight Mechanics, Propulsion and Aerospace Structures. The department houses one of a kind Flight Lab with three single engine airplanes, a motored glider and a 1000 m runway. The National Wind Tunnel Facility is one the few facilities available for public and private enterprises to test and correlate their results. Various other academic institutions and research organizations in India also make use of the department facilities.



## Message from HoD

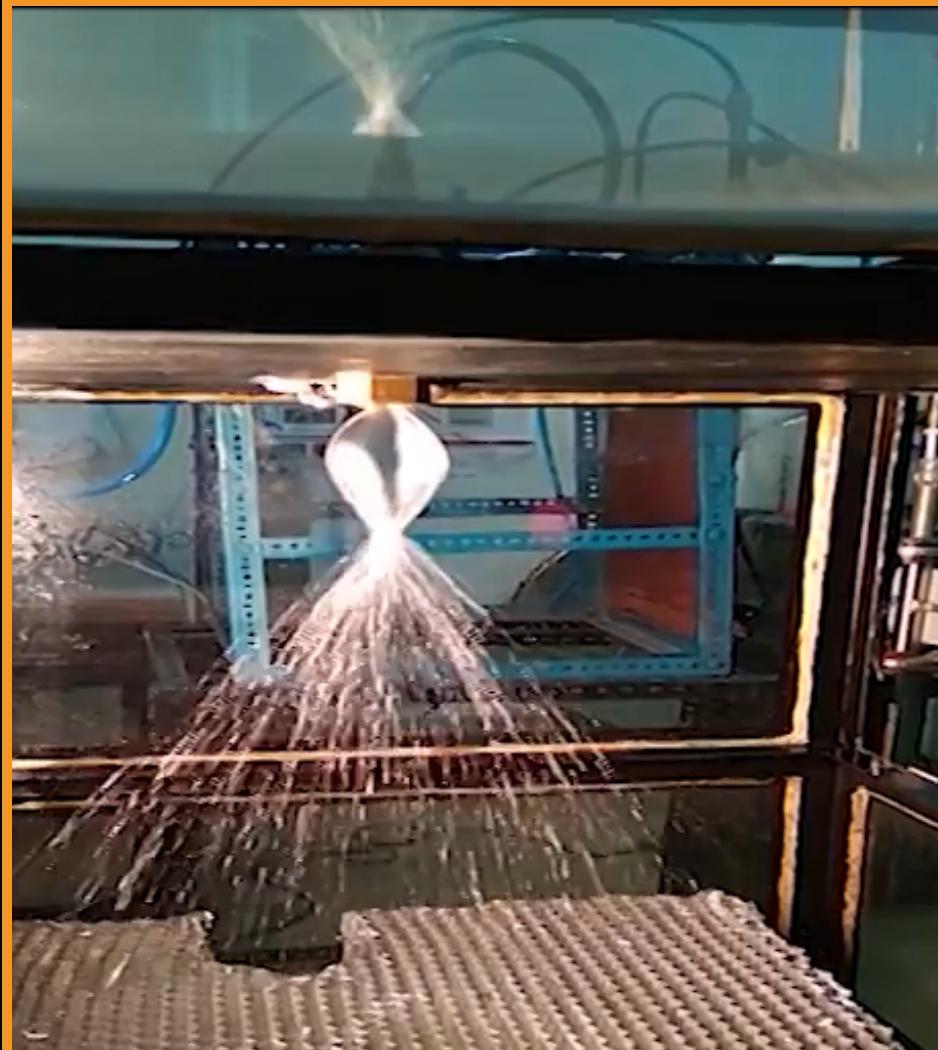
The Aerospace Engineering Department is more than 40 years old. Till 1991, it was known as Aeronautical Engineering Department. The name change was accompanied by addition of topics relating to spacecraft in the UG curriculum; some members of the faculty had been conducting research and guiding PG students in this area even before the formal alteration of the name in 1991. In matters of teaching, research & development, the department has always tried to strike a balance between hardware development and experiments on one hand, and theory and computational aspects on the other. The faculty strength currently is 30 (29 Regular & 1 Visiting). The department has 182 UG Students, 18 Dual Degree Students, 106 M.Tech students, 12MS (Research) and 140 Ph.D students.



Dr. Abhijit Kushari  
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Email: akushari@iitk.ac.in

The department has the following labs with a clear focus on teaching and research :

- Low Speed Aerodynamics Lab
- High Speed Aerodynamics Lab
- High Performance Computing Lab
- Aeromodelling Lab
- Computational Fluid Dynamics Lab
- Aero Propulsion Lab
- Structures & Material Characterization Lab
- Flight Lab
- Helicopter & VTOL Lab
- Advanced Combustion & Acoustics Lab
- Computational Propulsion Lab
- Structural Analysis Lab



Liquid Atomization  
Aero Propulsion Lab  
Lab incharge: Dr. Abhijit Kushari



# Curriculum

B . T E C H + D U A L D E G R E E .

M . T E C H .

P H D .

A c a d e m i c P r o g r a m s

(R) . M S .

# Major Courses

- Aerodynamics
- Aeromodel Design & Fabrication
- Aerospace Propulsion
- Aircraft Design
- Aeroelasticity
- Aircraft Structural Integrity
- Analysis & Composite Structures
- Advance Computational Fluid Mechanics
- Air-breathing Missile Propulsion
- Aerospace Structural Analysis
- Acoustics in Fluids
- Autonomous Navigation
- Boundary Layer Theory
- Boundary Layer Instability & Transition
- Combustion
- Compressible Aerodynamics
- Computational Fluid Dynamics
- Continuum Hypersonic Aerodynamics
- Composite Materials
- Dynamics & Vibration
- Finite Element Method
- Flight Mechanics & Controls
- Helicopter Theory
- High Temperature Gas Dynamics
- Hypersonic Flows
- Intro to Virtual Instrumentation
- Introduction to Aerospace Structures
- Molecular Gas Dynamics
- Numerical Modeling of Chemically Reacting Flows
- Optimal Space Flight Control
- Rocket Propulsion
- Space Guidance Navigation & Control
- Space Dynamics
- Solid Mechanics
- Turbo Machinery
- Turbulence
- Viscous Flows

# Infrastructure

## Low Speed Aerodynamics Lab

Lab incharge: Dr. Kamal Poddar

A fully functional facility to conduct wind tunnel experiments for the aerodynamic, propulsive and aero-elastic characterization of fixed, flapping and rotary wing and micro aerial vehicles. The lab has following wind tunnels to carry out experimental research in the areas of aerodynamics: Low turbulence tunnel, Boundary layer tunnel, Twin air or 5D tunnel, Water tunnel.

### Research Areas

- Unsteady Aerodynamics
- High AoA Aerodynamics
- Flow Control on airfoils, wings & other bodies
- Bluff Body Flows
- Wind Engineering
- Decelerator Aerodynamics
- Transition & turbulence
- Vortex Dynamics
- Granular Flows
- Dynamic Stall
- Separation Control
- Fluidic Oscillator



Wake of a plate hinged at its leading edge in pre and post oscillation regime  
Courtesy: Dr. Sanjay Kumar and Dr. Kamal Poddar

Flapping Wing UAV  
Unsteady Aerodynamics Lab  
Lab incharge: Dr. Debopam Das



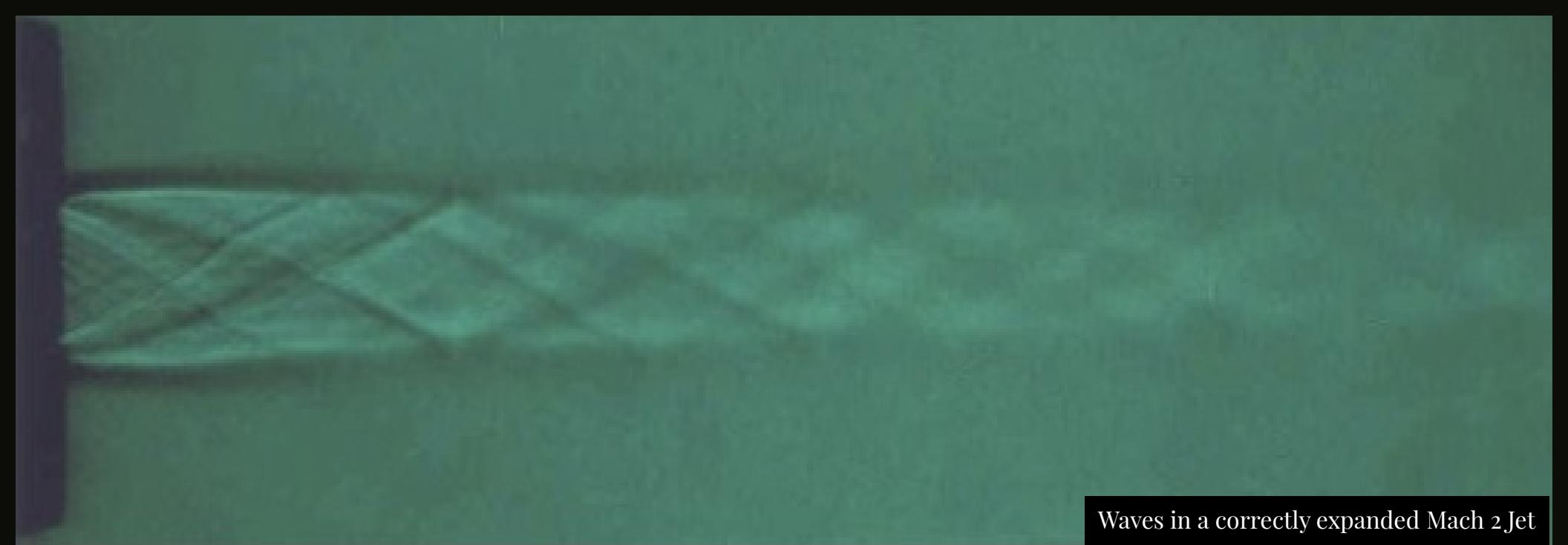
Wake of a rotationally oscillating cylinder at  $Re \sim 150$   
Courtesy: Dr. Sanjay Kumar and Dr. Kamal Poddar



Wake of a rotating cylinder at  $Re \sim 250$  in a soap film tunnel  
Courtesy: Dr. Sanjay Kumar



Shock interactions in granular flows at  $M \sim 9.1$   
Courtesy: Dr. Sanjay Kumar and Dr. Rakesh Mathpal

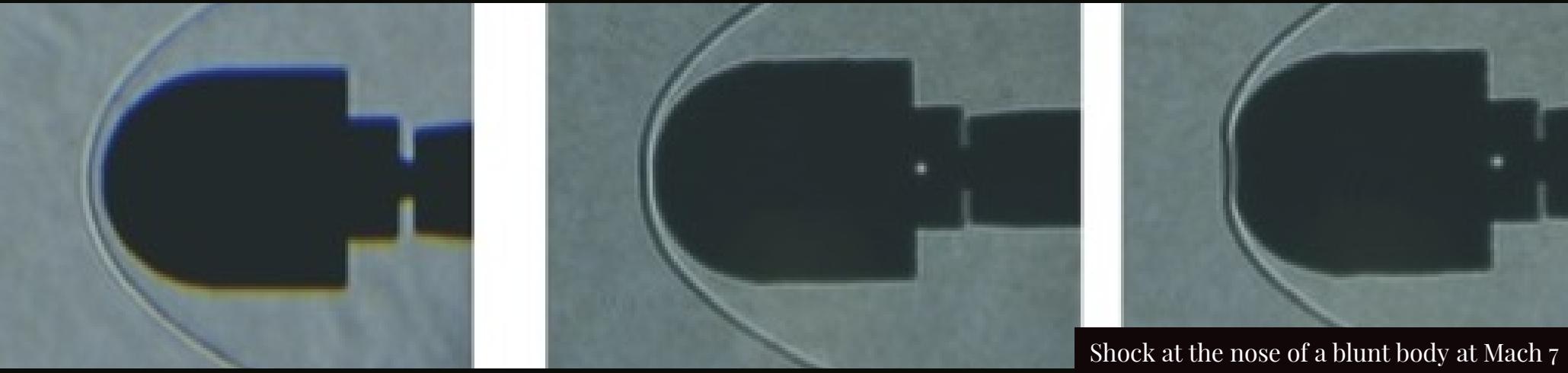


Waves in a correctly expanded Mach 2 Jet

## High Speed Aerodynamics Lab

Lab incharge: Dr. Mohammed Ibrahim Sugarno

This lab of our department is well known for the research in the area of gas dynamics. The lab also houses an intermittent, blowdown type supersonic wind tunnel. The tunnel is equipped with a dedicated computer system for tunnel control and data acquisition. This facility has already made substantial contribution in establishing new testing techniques and basic research in the area of transonic/supersonic flows.



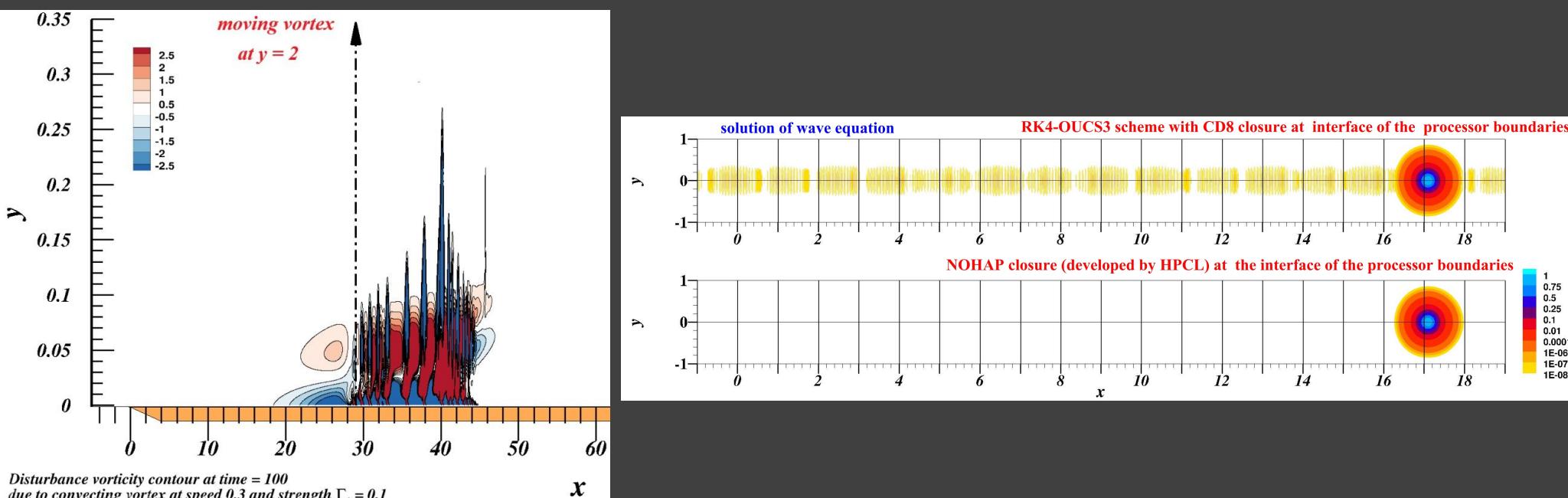
Shock at the nose of a blunt body at Mach 7

## Research Areas

- Gas Dynamics: experimental & theoretical investigation
- Rarefied Flows
- Applied Gas Dynamics & High Speed Jets
- Sudden Expansion Problems
- Supersonic, Transonic & Subsonic Aerodynamics

# High Performance Computing Lab\*

The primary focus is on developing and implementing high fidelity computing methods for various flows, including subsonic, supersonic, and hypersonic. The emphasis of the research is on developing high accuracy computing methods to aid in bridging the gap between theoretical and computational fluid dynamics and heat transfer. The instability, transition to turbulence, and control of fluid flows are analyzed in theoretical and computational framework with the help of in-house developed tools.



## Research Areas

- High accuracy, scientific computing from the first principle
- Theoretical analysis of precursor of instability and transition of fluid flows.
- Receptivity analysis and transition control by DNS and Implicit LES.
- Multiple Hopf bifurcations and proper orthogonal decomposition.
- Development of coherent structure detection methods.
- Global spectral analysis of numerical schemes.

\*HPC Lab continues to exist, even though Prof.Sengupta (Lab Incharge) has moved to IIT Dhanbad.

# >Aeromodelling Lab<

Lab incharge: Dr. Subrahmanyam Saderla

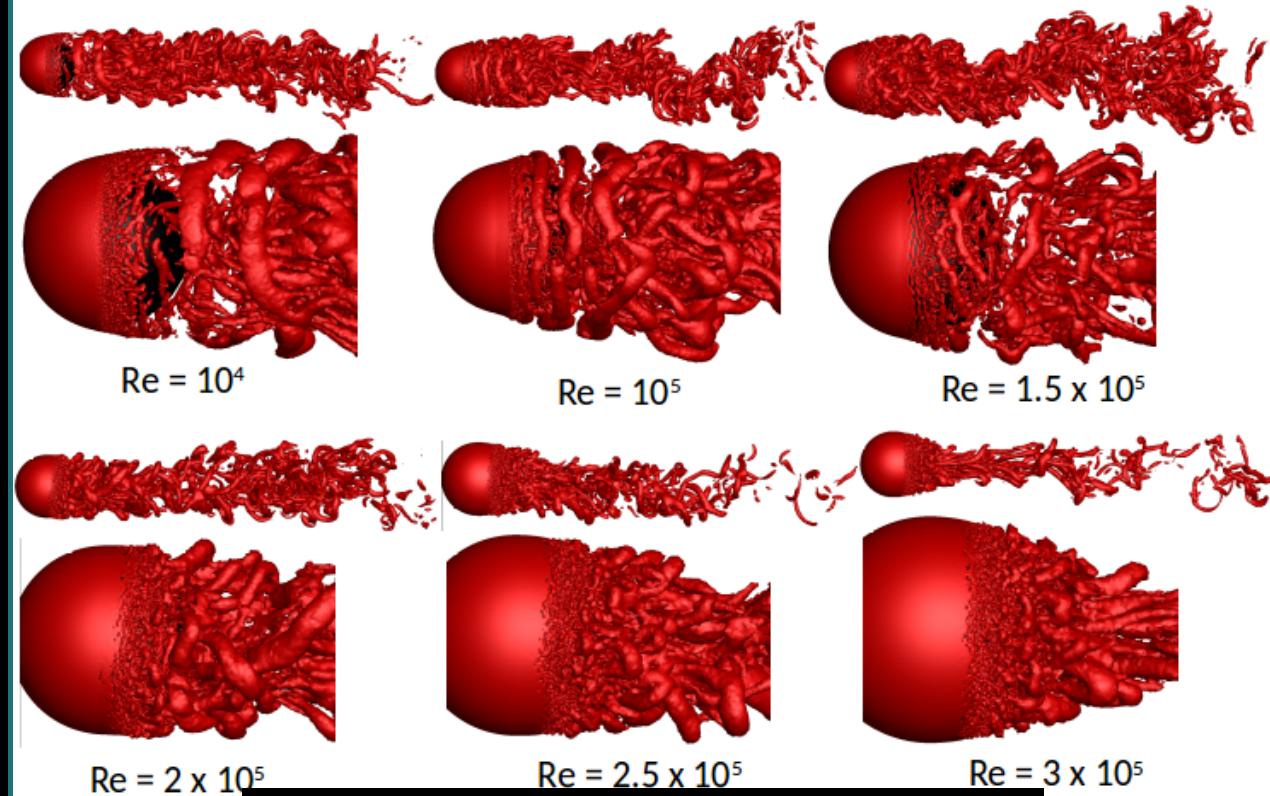
In the Aeromodelling Lab, students design, fabricate and fly models. It not only gives a primary introduction to the world of aerodynamics, designing, electronics, engine technology, wood crafting and the technology of new materials but also provides a hands-on experience necessary for developing a practical aptitude.



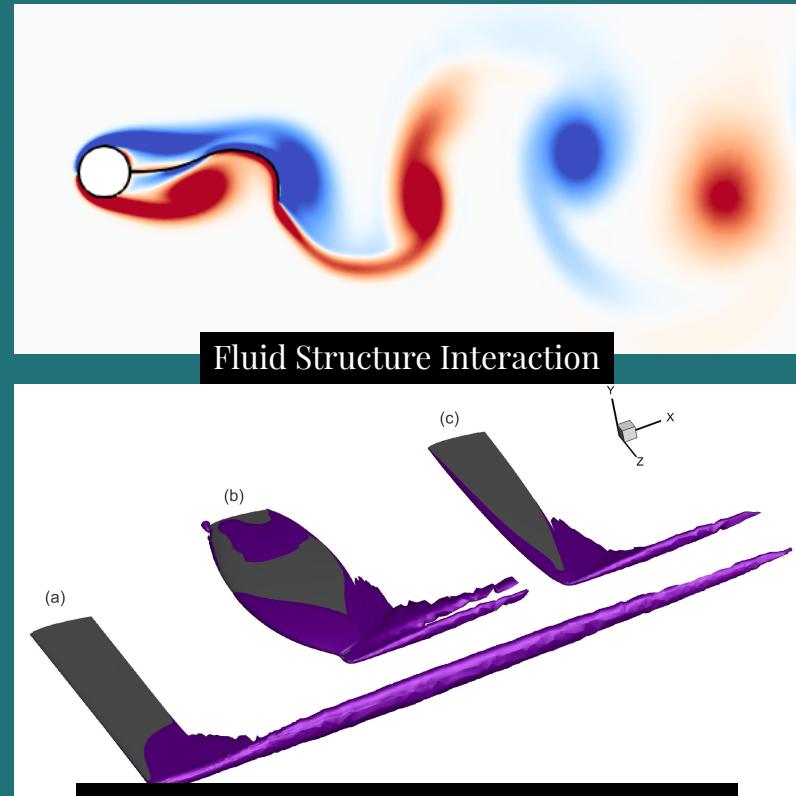
# > Computational Fluid Dynamics Lab <

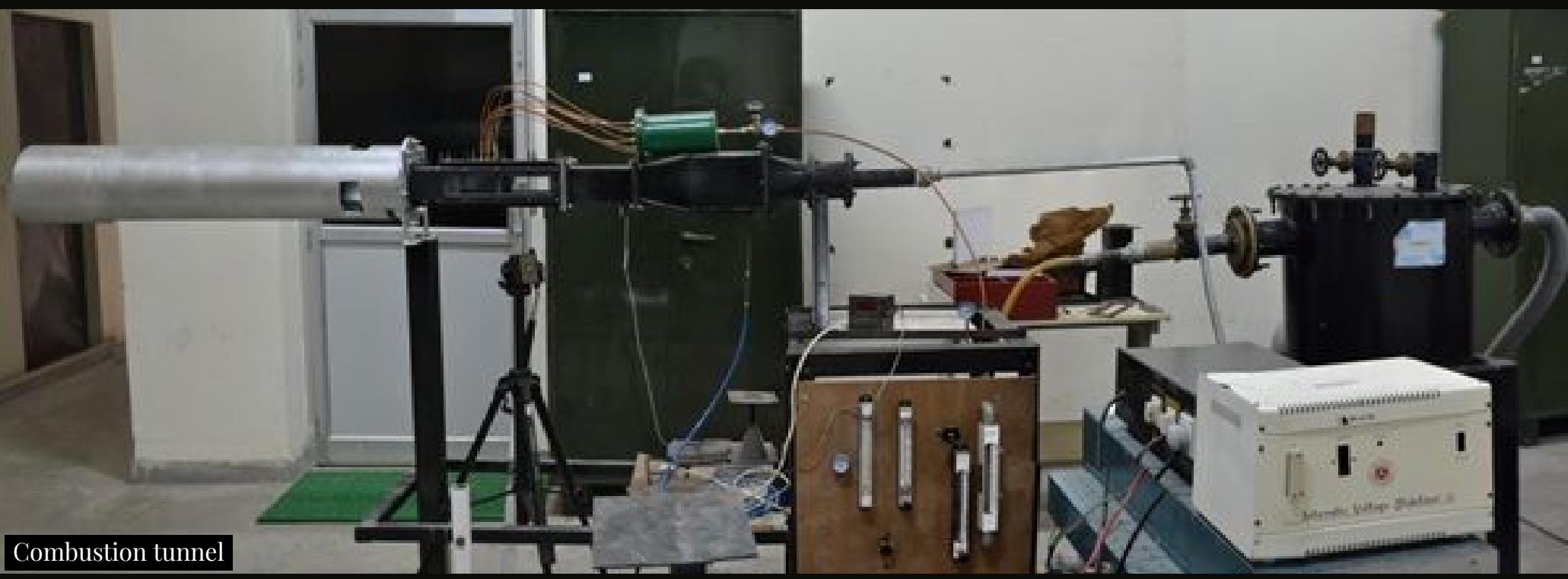
Lab incharge: Dr. Sanjay Mittal

CFD lab facilitates study basics of fluid flow, design of numerical methods as well as their application to situations of practical interest. Scientific investigations mostly involve fundamentals of flow phenomena, e.g. stability and turbulence.



Transition of the boundary layer on a smooth sphere





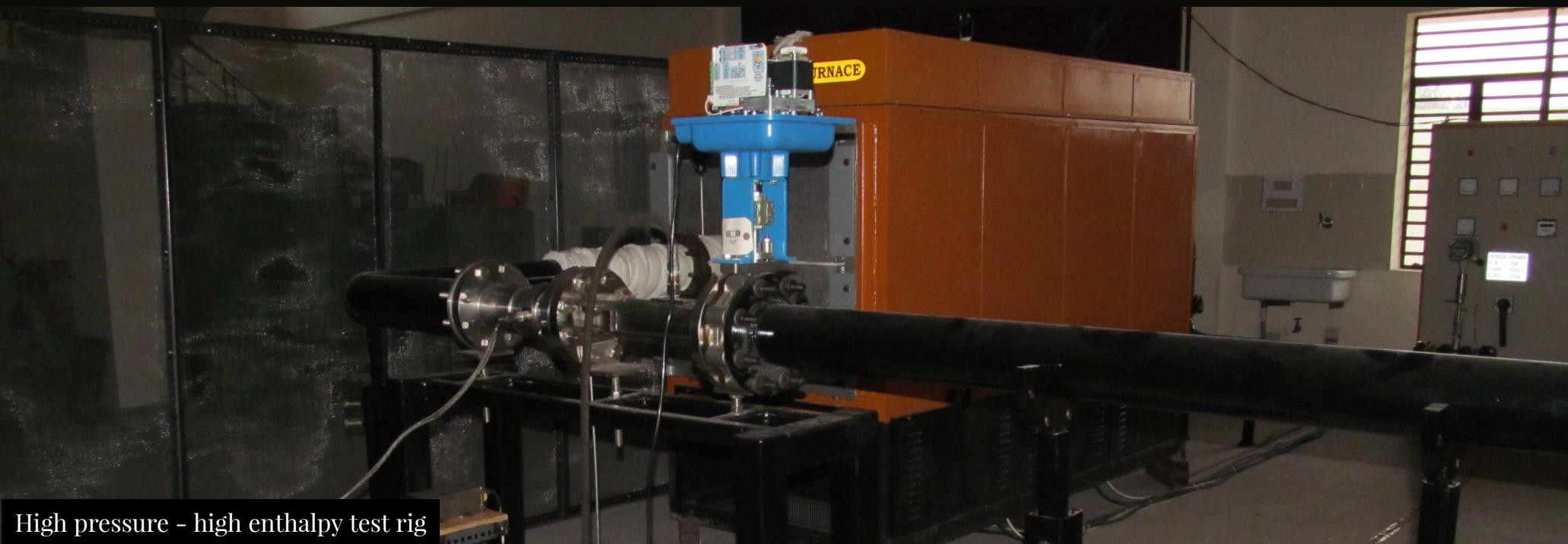
## ➤ Aero Propulsion Lab <

Lab incharge: Dr. Abhijit Kushari

The lab is equipped with a continuous combustion unit where heat balance studies, exhaust gas composition, effect of fuel and flame stability test can be performed. Following are the facilities available in lab: low speed cascade wind tunnel, 2-shaft gas turbine, continuous combustion unit, gaseous fuel combustion test rig, dump combustor with optical windows.

## ➤ Research Areas <

- Flow Diagnostics
- Internal Flow Control (Active & Passive)
- Liquid Atomization & Spray Combustion
- Thrust Vectoring
- Electric Propulsion
- Aeroelasticity
- Linear Cascade Compressors

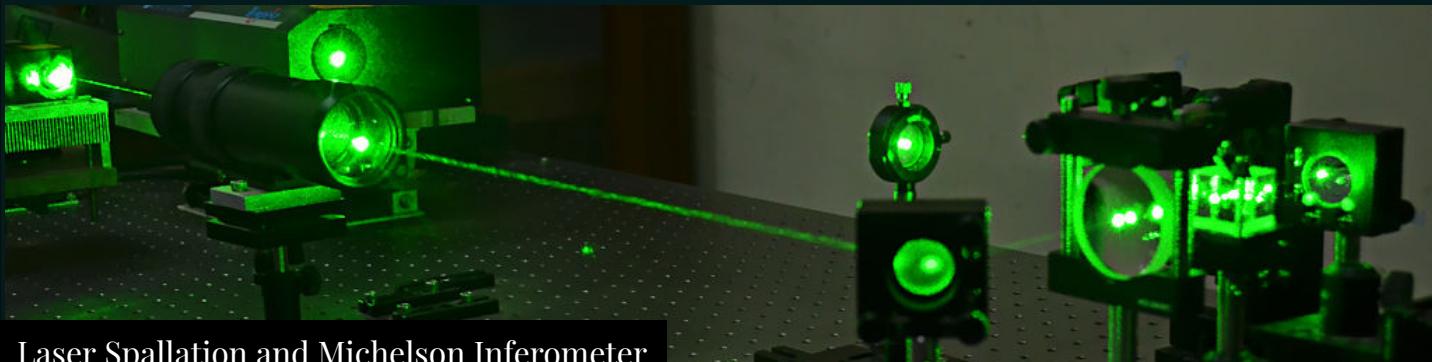


High pressure - high enthalpy test rig

# Structures & Material Characterization

Lab incharge: Dr. Rajesh Kittey

Over the last few years we have been developing and testing smart structural system engineering structures with integrated sensor, information processing, feedback control and actuating devices. The smart structures experiments have been related to building innovative smart sensors, vibration control and structural health monitoring concepts. Research efforts are directed towards focused on fabricating smart materials such as piezoelectric materials and hydro gels and damage diagnostic methods.



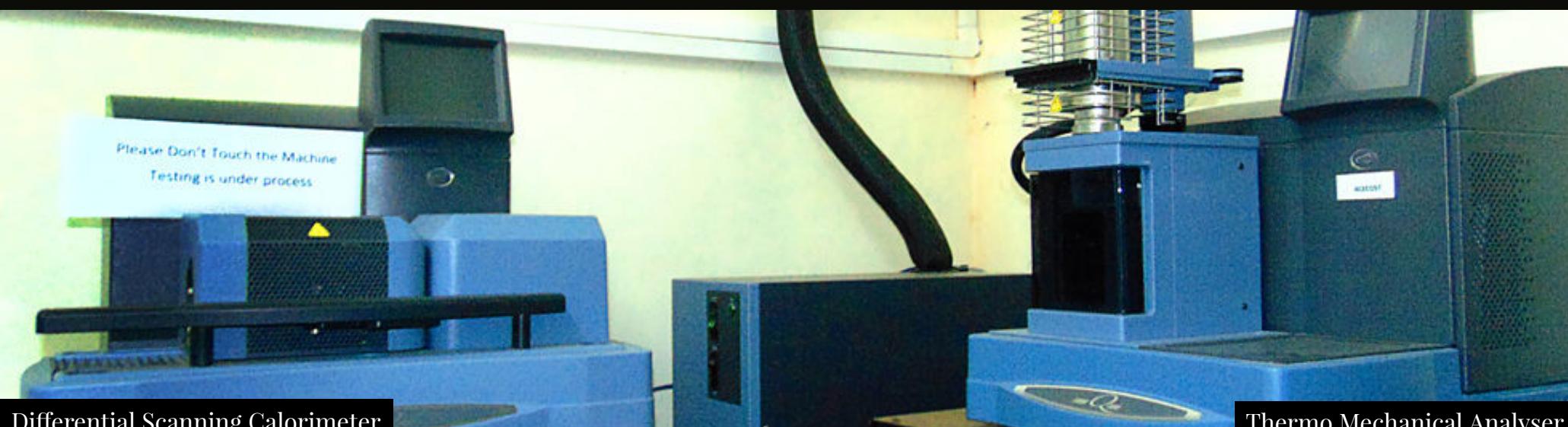
Laser Spallation and Michelson Inferometer



Universal Testing Machine

## Research Areas

- Stochastic Analysis
- Smart Structure Modeling & Analysis
- Generalized Damage Mechanics
- Composite Structure Analysis & Design



Differential Scanning Calorimeter

Thermo Mechanical Analyser



## ⟩Flight Lab⟨

Lab incharge: Dr. G. M. Kamath

The flight lab is a unique national facility with three single engine airplanes: Cessna 206H, Hansa-3 and Piper Saratoga. The Flight Lab also has a Pipistrel Sinus 912 motored glider. The operations and maintenance of the Flight Lab are carried out in compliance with DGCA regulations. The Flight Lab conducts courses for students wherein they are taught various aspects of conducting experiments in flight, and obtaining and analysing different aircraft flight parameters. The lab also provides an opportunity for faculty focusing in broad areas of aircraft structures, flight mechanics, aerodynamics and avionics to conduct experiments as part of their research.

## ⟩Research Areas⟨

- Parameter Estimation
- System Identification
- Guidance & Control of Aircraft & Unmanned Aerial Systems
- Aircraft Structural Health & Usage Monitoring



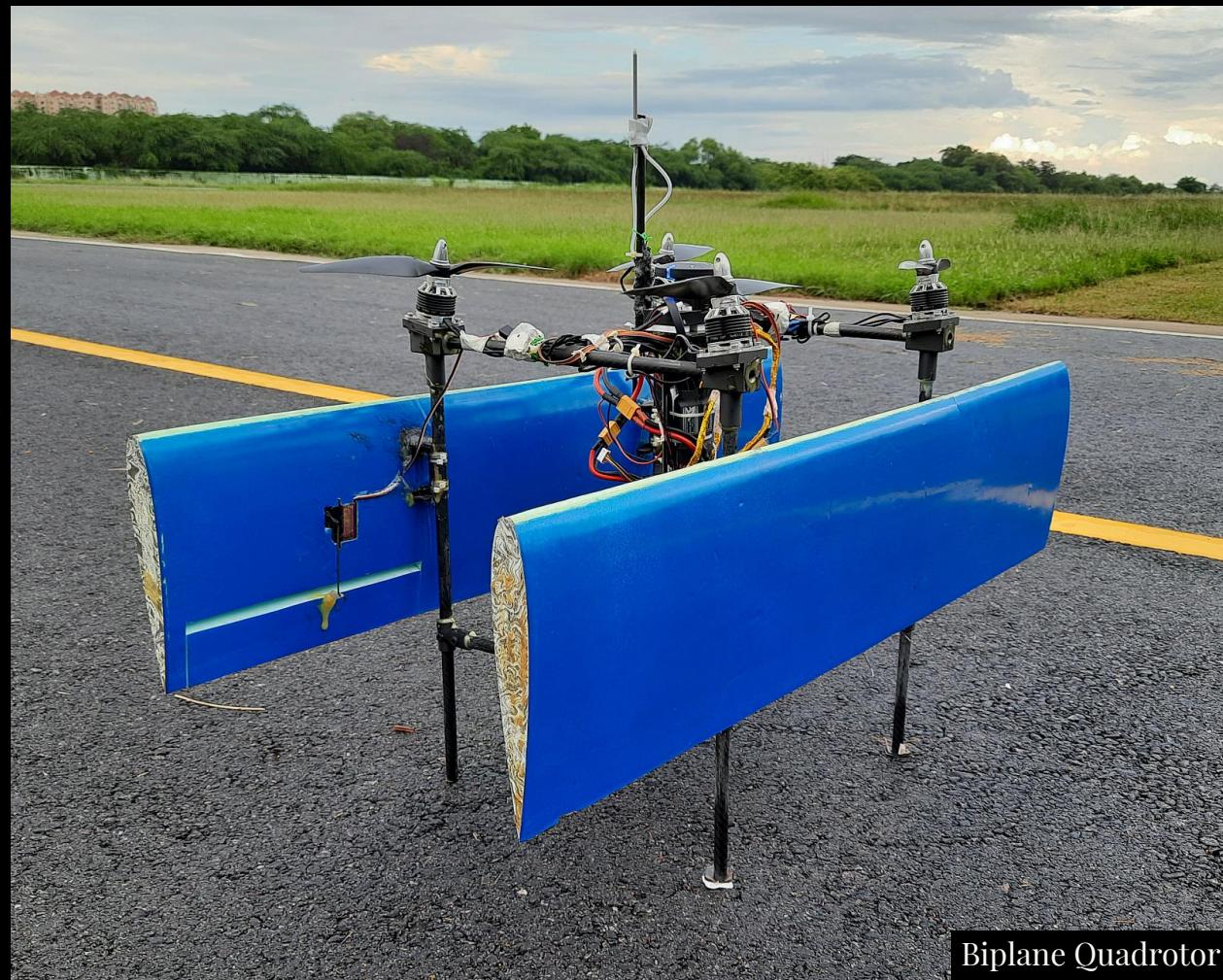
# ➤ Helicopter & VTOL Lab

Lab incharge: Dr. Abhishek

This focuses on the fundamentals of design, manufacturing and testing of systems. Also subsystems for a mini-helicopter are developed. Autonomous Mini-Helicopter which while weighing only a few kilograms incorporates most of the functions of a real life helicopter and achieves autonomous flight.



Autonomous Mini Helicopter



Biplane Quadrotor

## ➤ Research Areas

- Design & Development of avionics package:
  - a• Ground Control
  - b• Sensing & Actuation
  - c• Communication Navigation
  - d• Automatic Flight Control
- Flight Testing of autonomous Helicopter & expanding its utility by making the vehicle perform intelligent tasks.
- Structural design & development of a mini helicopter

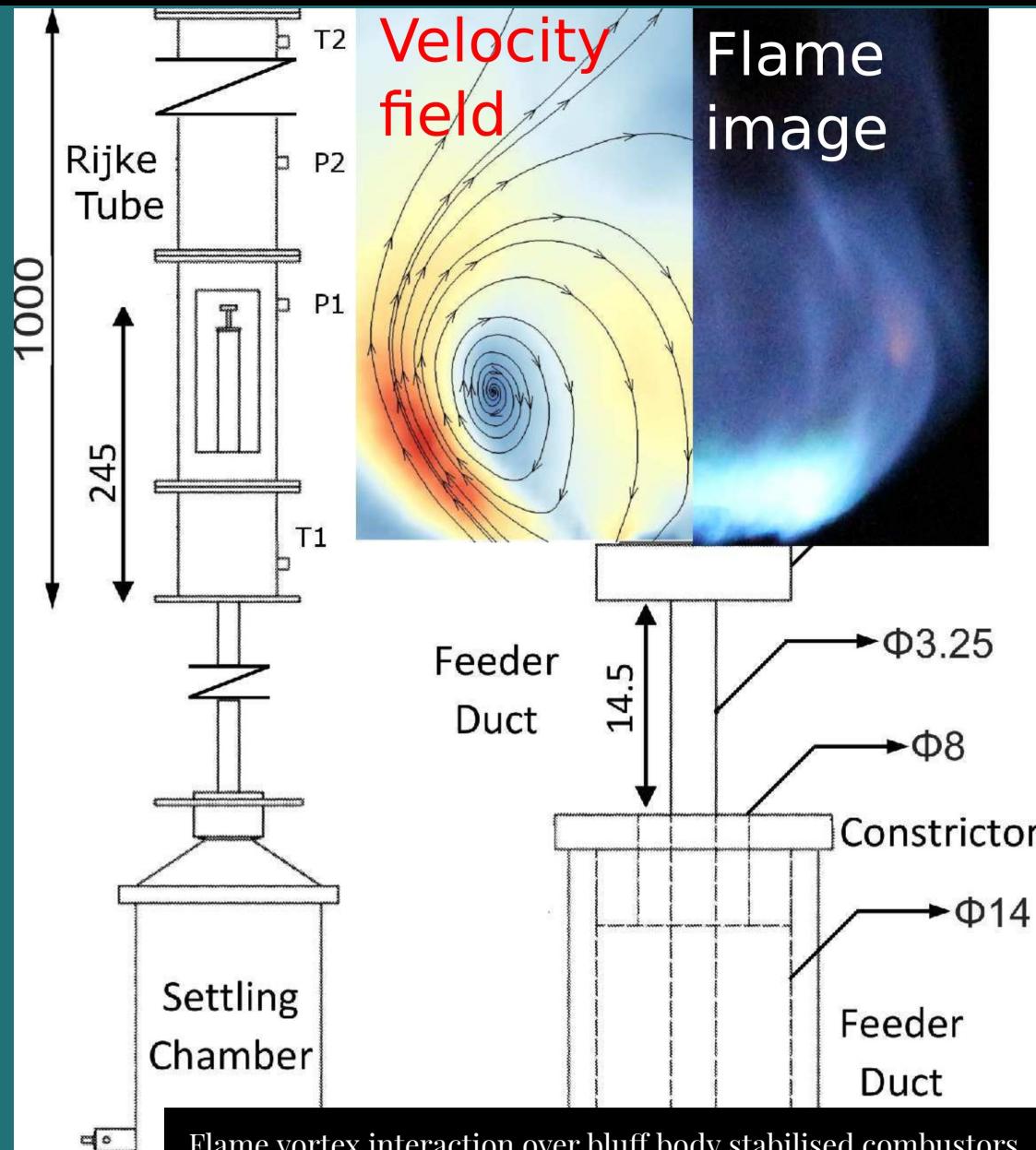
# Advanced Combustion & Acoustics Lab

Lab incharge: Dr. Sathesh Mariappan & Dr. Vaibhav Arghode

Perform investigations in in-house developed test rigs, which are instrumented with state of art measuring instruments. Experiments are performed in a wide variety of configurations, starting from a simple Bunsen type burner to a realistic gas turbine type annular combustor. Perform numerical investigations and validate experimental findings.

## Research Areas

- Design clean and quiet combustors for fuel lean conditions
- Reduce unwanted large amplitude flow oscillations in Combustion Chamber
- Mitigating Combustion Instability
- Thermoacoustics Interactions
- Colorless Diffusion combustion
- Alternative Fuel & Combustor Performance



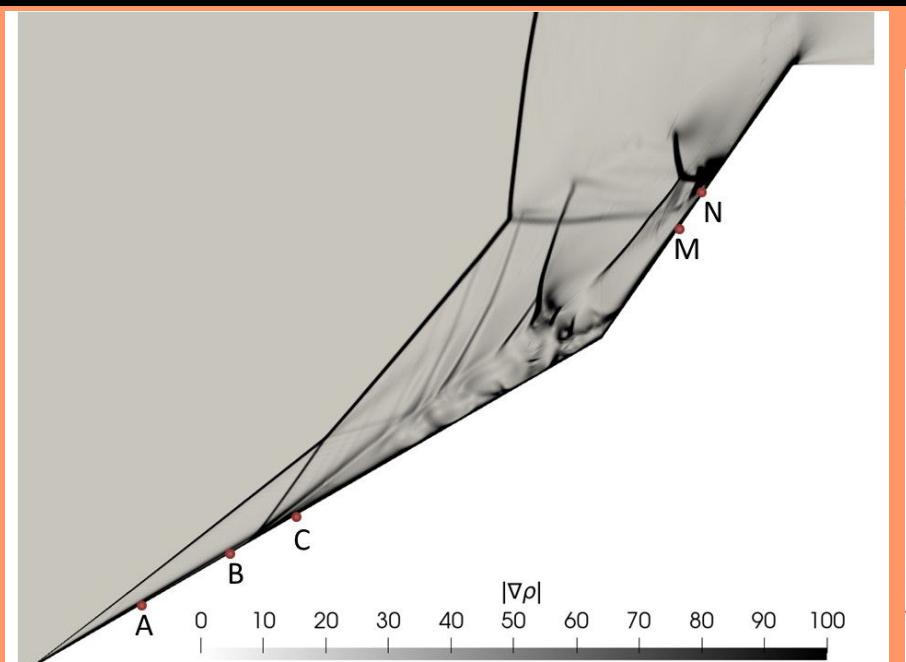
Flame investigation for dump combustors

Flame vortex interaction over bluff body stabilised combustors

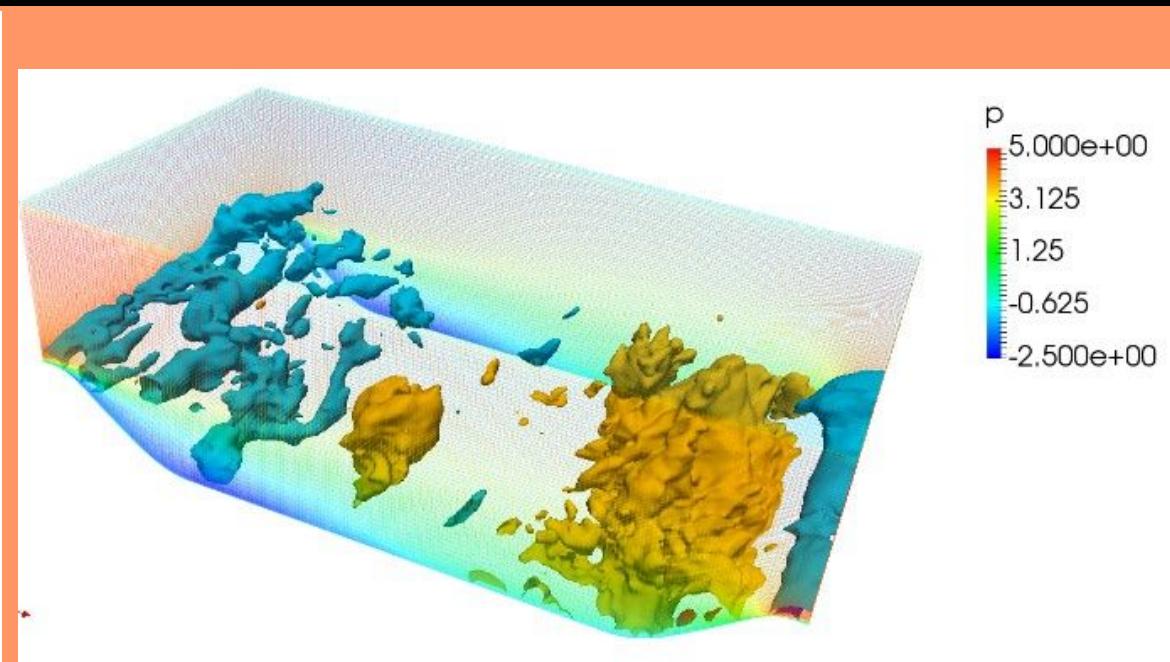
# Computational Propulsion Lab

Lab incharge: Dr. Ashoke De

The lab is primarily focused on computation-based research in the area of Fluid Dynamics and Combustion. We are involved in both development, and application of algorithms for fluid flow, heat and mass transfer. At CPL, we work on cutting-edge research using CFD and their application to multidisciplinary engineering problems starting from Mesoscopic level to programs in Space, Energy, Aero-elasticity. Applications include all regimes of steady-unsteady flows in combustion as well as in gas turbines, acoustics, turbulence modeling, supersonic flows, fluid-structure interaction, conjugate heat transfer and multidisciplinary fluid flow problems. We are involved in the simulation of the problems in areas of RANS, LES, hybrid RANS-LES, DNS, Lattice-Boltzmann, depending on its type and conditions.



Density gradient for a hypersonic flow at Mach 7 over a double wedge



Pressure iso-surface for turbulent flow over periodic hill

## Research Areas

- High Speed Flows
- Flow-Acoustics Coupling
- Fluid-Structure Interaction
- Turbulence Modelling: DNS, LES, Hybrid RANS/LES
- Combustion & Multiphase modelling
- Flow Control

# Structural Analysis Lab

The research domain comprises of both fundamental and advanced problems that arise in the areas of research. Several high-end state-of-the-art computational codes have been developed in-house for multi-scale mechanics for damage; damage mechanics based modeling of composite structures; modeling and analysis of piezo-material based structures; adaptive modeling of laminated plates; structural optimization and stochastic analysis of laminated structures.



DMA machine



UTM 200kN



Helicopter blade & mould



Hydraulic chamber

## Research Areas

- Solid Mechanics
- Damage & Fracture Mechanics
- Adaptive FEM
- Structural Dynamics
- Stochastic Processes & Structural Optimization

## Year 2020 till now

- [1] A Study of Gas-Surface Interactions using Particle based Methods for Rarefied Gas Flows

## Year 2019-20

- [1] Sharp Interface Immersed Boundary Framework for All-Speed Flow Solver
- [2] Receptivity, instability and structure identification in three-dimensional routes of transition
- [3] Influence of filler shape and strain rate on the mechanical and failure characteristics of glass-filled Epoxy composites
- [4] Attitude Control of Agile Rotorcrafts: A Geometric Approach
- [5] A Micromechanical Study of Unidirectional Fibre Composites with Emphasis on Randomness in Spatial Distribution, Boundary and Interface Effects
- [6] Linear and non-linear Aerodynamics parameter estimaton using genetic algoritm
- [7] Linear instability of transient flows: Numerical approach and experimental validation

## Year 2018-19

- [1] High Accuracy Time-Accurate Computing of Three-Dimensional Flows
- [2] Machine Learning Methods for Aerodynamic Modeling and Parameter Estimation
- [3] Large-Eddy Simulation of Mixing Characteristics in Strut Injectors
- [4] Control of Shock Wave Boundary Layer interaction using Active and Passive Devices
- [5] Shifted Tabs for Supersonic Jet Control
- [6] Control effectiveness of modified triangular tabs for supersonic elliptic jet mixing
- [7] Development and Aerostructural Analysis of Biomimetic Flapping Wings



# Faculty



## Aerodynamics

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Debopam Das, PhD (IISc Bangalore)  
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Arun Kumar Perumal, PhD (IIT Kanpur)  
Assistant Professor  
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Mohammed Ibrahim Sugarno, PhD (IISc Bangalore)  
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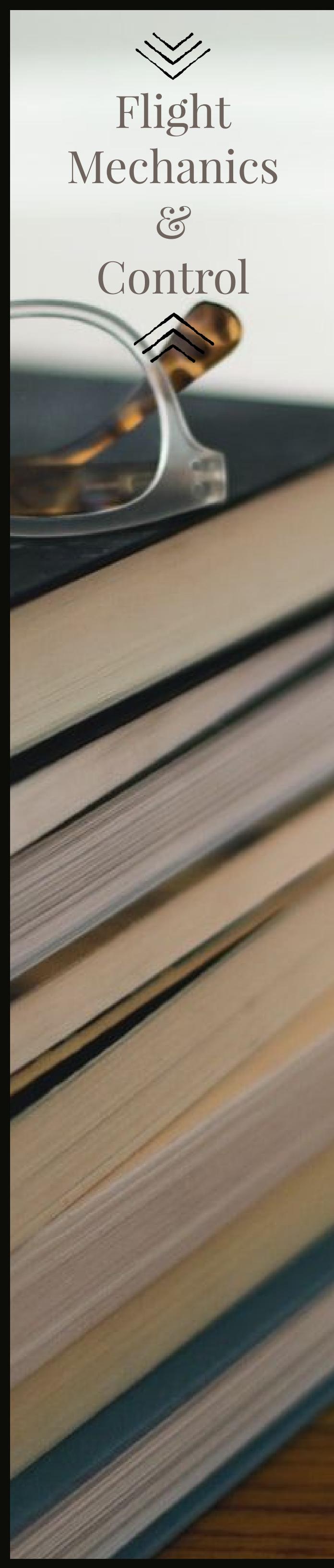
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Associate Professor  
Research Interests: Fluid Dynamics, Aeroacoustics, Wave Mechanics, Linear & Non-linear Stability, Flow Control.  
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# Flight Mechanics & Control

A. K. Ghosh, PhD (IIT Kanpur)

Professor

Research Interests: Parameter Estimation from Flight Data, Neural Modelling, Design of Air Borne Stores: Aircraft Bombs, Artillery Shells & Rockets, Design of Control Law of Guided Missiles.

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Ashish Tewari, PhD (Missouri-Rolla)

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Mangal Kothari, PhD (University of Leicester)

Associate Professor

Research Interests:

- Aerial Robotics: Flight Vehicle Guidance and Control (Fixed-Wing, Rotorcraft, Multi-rotor, VTOL); Autopilot Development: Embedded Systems, RTOS; Motion Planning, Coordinated control of UAVs/MAVs; State Estimation: AHRS, Localization, GPS Denied Navigation, SLAM; Machine Learning & Computer Vision
- Spacecraft Mechanics
- Optimal Control, Nonlinear & Adaptive Control
- Stochastic Planning under Uncertainty

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Research Interests: Real Time System Identification of UAV, Dynamic Wind Tunnel Testing, Chaotic Modelling (of Cancer Cell growth, Seismic Data & Material Properties) using Artificial Neural Networks.

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# Propulsion



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Professor & Head

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Research Interests: High Speed Flows, Flow-Acoustics Coupling, Fluid-Structure Interaction, Turbulence Modelling, Combustion and Multiphase modelling, Flow Control.

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# Structures, Structural Dynamics & Aeroelasticity

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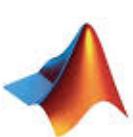
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