

Indian Institute of **IITK** Technology Kanpur

Established in 1964, this department is a premier teaching and research centre. It is engaged in engineering science instruction, aerodynamic testing, in-flight laboratory work, indigenous design and fabrication of advanced facilities and instruments. The department offers specialization in various aspects of Aerospace Engineering, which includes aerodynamics, aerospace structures, propulsion, flight stability and control, helicopter dynamics, space dynamics, missile guidance, control and instrumentation. In-depth courses offered by competent faculty prepare the students for an exciting career to effectively contribute in National and International projects.

Aerospace Engineering



Areas of Research

- ✦ Computational Fluid Dynamics
- ✦ Experimental Aerodynamics
- ✦ Wind Tunnel Testing of Tall chimneys and Industrial Structures
- ✦ Wind Tunnel Testing, Flight Testing, Noise Control, Vibration Testing
- ✦ Aerodynamics of Vertical Axis Wind Turbines
- ✦ Unsteady Aerodynamics, Flapping Wing Aerodynamics
- ✦ Transition and turbulence
- ✦ Flow Induced Vibrations
- ✦ Aerodynamics shape Optimization
- ✦ Structural Dynamics, Vibration and Control, Smart Materials & Structures
- ✦ Unsteady Aerodynamics, Helicopter dynamics
- ✦ Composite Materials and Structures; Damage Mechanics
- ✦ Dynamics, Control and Guidance of Atmospheric Flights Vehicles and Spacecrafts
- ✦ Active Control of internal flows
- ✦ Aeroacoustics
- ✦ Aerodynamics of air-intakes



High Speed Aerodynamics Lab provides facilities in the areas of high speed jet mixing and acoustics, supersonic combustion. The lab also houses an intermittent, blow down type trisonic wind tunnel equipped with a dedicated computer system for tunnel control and data acquisition.

Low Speed Aerodynamics Lab is equipped with Low Turbulence Tunnel, Boundary layer Tunnel, Twin Air or 5-D Tunnel, Smoke Tunnel to carry out experimental research in the areas of aerodynamics. Pulsed Laser for high speed visualization.

The **Flight Laboratory** is a unique facility with four single engine airplanes: **Piper Super Cub** - a two seater, **Cessna Skylane** - a four seater and **Piper Saratoga** - a six seater and Hansa-III-a two seater fully instrumented aircraft. The lab also has several gliders, operational aerodrome and active gliding center. The flight laboratory runs courses in flight testing wherein students participate to collect, analyze and evaluate performance and handling qualities of the airplanes. Flight Laboratory is equipped with appropriately instrumented aircraft to conduct experiments/ Research in the area of parameter estimation, atmospheric characterization etc.

The **Propulsion Laboratory** is equipped with a cascade tunnel, LDA, combustion test facility. Additional facilities include Phase Doppler Particle Analyzer, Electric Micro-thruster setup, Setup for aero-elastic studies of cascades, Spray Characterization setup, Tunable ram combustor for study of combustion oscillations, Experimental dump combustor, Liquid fuel combustion, Spray and atomization, Droplet combustion

The **Structural Laboratory** has experimental facilities for photo-elasticity material characterization, composite fabrication and testing, fabrication and testing of smart materials/structures.

Structural analysis laboratory is engaged in research in the areas of stochastic material modeling, modeling of damage in composite multi-scale analysis, computational aeroelasticity, modeling and analysis of smart materials and structures.

Autonomous helicopter lab is under construction

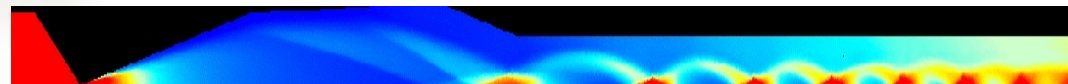
In addition to these laboratories the department also houses the **Computational Fluid Dynamics Lab**, a nodal center of excellence, AR&DB.

Ongoing Research Projects

- TRPIV study to understand IOP of GSLV MACH III (ISRO)
- Aerodynamic characterization of Lattice and cascade fins for stabilising missile body.
- Flight dynamic simulation of Parafoil
- High angle of attack aerodynamics studies using windtunnel
- Droplet-Flow Ingeraction in Re-circulating Turbulent Flows (ISRO-STC)
- Development of Hybrid Pulsed Plasma Thruster (ISRO-STC)
- Experimental Study of Aeroelastic behaviour of cascades(AR&DB)
- Identificaiton, Analysis and Control of Flow Angularity in Thrust Vecteded Nozzles (AR&DB)
- Aerodynamic Characterization of Projectiles with Wrap Around Fins(ARMREB)
- Flow Control in Serpentine Intakes using Pulsed Vortex Generator Jets (AR&DB)
- Numerical and Experimental Study Droplet Combustion under Normal and Microgravity Conditions (ISRO Bangalore)
- Experimental Study of Liquid Fuel Combustion using Chemiluminescence Sensor (DRDO New Delhi)
- Instabilities in air-intakes (ARDB)
- Study of Dynamic Stall on and Oscillating Air foil (ARDB)
- Numerical Methods for Fluid Mechanics & Acoustics (CEFIPRS)
- Natural Laminar Flow Wing Design (ARDB)
- Design and Development of autonomous mini helicopter (DST)

Ongoing Consultancy Projects

- ✦ Dynamic stability of wrap around fin artillery rockets
- ✦ Safe sabot separation dynamics of anti tank ammunition
- ✦ Evaluation of Design for Pinaka rocket DA/SD Fuze through flight test bench and wind tunnel testing.
- ✦ Effect of Additive on Specific Fuel Consumption and Emission Level of a Diesel Engine (Achintya Gamut Omni India)



Pressure in a model supersonic wind-tunnel (computed using a finite element program developed at IIT Kanpur).

Ongoing Research Activities

The department has been actively contributing to various projects of national importance. Some of the sponsoring agencies include: AR&DB, DST, ISRO, ADA, CSIR, AICTE, INSA, HAL, ADRDE, IRDE, ARDE, BEL, DRDO, ARMREB, DRDL. The current research activities focus on :

Experimental Mechanics

- ✦ Design and testing of nozzles for high-speed jet flows.
- ✦ Measurement and suppression of flow-induced noise.
- ✦ Design and testing of flapping wing micro arial vehicle
- ✦ Design and testing of wind-turbines.
- ✦ Liquid fuel, Fuel atomization, Combustion diagnostics and control.
- ✦ Identification of surge precursors and control of surge in axial fans
- ✦ Development of an auto-ignited pulsed plasma thruster
- ✦ Numerical study of fire extinguishment in an enclosure
- ✦ The effect of inlet disturbances on bluff body stabilized combustion
- ✦ Flow dynamics inside a low aspect ratio dump combustor with tapered exit
- ✦ Trapped vortex combustor; spray and atomization. Droplet, supersonic, Liquid fuel combustion
- ✦ Parameter estimation using neural network based methods
- ✦ Design and testing of rail fastening mechanisms
- ✦ Fabrication of smart sensors and actuators
- ✦ Design, fabrication and flight dynamics simulation of autonomous mini helicopters
- ✦ Formulation and Solution of Coupled Bending Torsion Flutter in Turbo machinery Blades
- ✦ Dynamics and control of smart structures

The **National Wind Tunnel Facility**, designed and developed by the Aerospace Engineering Department, IIT Kanpur, a state-of-the-art 3m x 2.25m Low Speed Closed Circuit Wind Tunnel with modern instrumentation and equipment has been established as a national facility to meet the national need in the areas of aeronautical and non-aeronautical related R&D work. With a very large test section, 90m/s wind speed and turbulence level less than 0.05%, this Tunnel is capable of testing a full-scale model of a car. To carry out experimental research in the area of aerodynamics, NWTF is the only facility of its kind. All M.Tech. students are encouraged to do experiments in NWTF.

Computational Mechanics

Aerodynamics : Unsteady aerodynamics, Parachute Aerodynamics, Aeroservoelasticity, Vortex Induced Vibrations, Fluid-Structure Interactions, Airturbo-ramjet parametric studies, High angle of attack Missile control Aerodynamics and dynamics, Control of secondary flows and separation using active and passive devices, Effect of free-stream turbulence on wing and bluff body aerodynamics, Vortex ring, DNS-LES of turbulent vortices, Boundary element method (BEM) modeling of vascular microbubbles, Vibration induced perturbations in flow through closed conduits, Hypersonic Flow, Bypass transition and its modeling. Transition. Free stream Turbulence & Bluff body flows, Aerodynamic shape optimization

Propulsion : Aero intakes for Missiles and Scramjet Engines, Reacting Flow(CFD), Premixed Combustion, Turbulent Flame, Heat Transfer, flow-heat transfer problems

Structures : Smart Structures, Stochastic Analysis of Composite Structures, Damage and Fracture Mechanics in composites, Helicopter Dynamics and Control, multi-scale Analysis, FEM, Development of an autonomous helicopter, Aeroelastic/Aeromechanics Analysis of coupled rotor/fuselage helicopters system

Flight Mechanics : Neural Networks, Trajectory Estimation of Aircrafts and Missiles, Vibration Suppression, Nonlinear Optimal Control of Attitude dynamics Aeroservoelasticity Space Dynamics & Control. Design and development of stability unit having ring tail configuration for aircraft bombs.

The computational activities rely on the hardware in the department and on the Central Computing Facility of the Institute, which has several multi-processor compute servers, parallel computers.

Other Activities : Lectures on “Finite Element Method” were delivered under NPTEL. The contents are available on You Tube

Books

- R.K.Sullerey*, Editor, Proceedings of 7th National conference on Airbreathing and aerospace propulsion Nov-05 -07-2004
- E.Rathakrishnan*, Fluid Mechanics : An Introduction, Prentice Hall of India, New Delhi, 1993.
- A.Tewari* , Modern Control design, John Wiley, Chichester, UK, 2002
- A.Tewari*, Atmospherical Space Flight Dynamics, Birkhainser Boston, 2005
- T.K. Sengupta*, Fundamentals of Computational Fluid Dynamics University Press, Hyderabad, 2004
- E.Rathakrishnan*, “Gas Dynamics, Prentice Hall of India Pvt. Ltd., 2008
- D.P. Mishra*, Fundamentals of Combustion, Prentice Hall of India, New Delhi, 2008
- D.P. Mishra*, (Ed) “Proceedings of National Seminar on Combustion”, Allied Publisher, New Delhi, 2005.
- A.K.Ghosh and D.P. Misra*, (Eds.) “Proceedings of 21st National Convention of Aerospace Engineers”, 16-17th Nov 2007, IIT,Kanpur

- ✦ **A.K.Ghosh** : Missile guidance and control, Neural Networks, Parameter Identification
- ✦ **A.Kushari** : Propulsion, Combustion, Aero-Thermodynamics
- ✦ **A.Tewari** : Aeroservoelasticity, Unsteady Aerodynamics, Nonlinear Optimal Control
- ✦ **Brijesh. Eshpuniyani** : Transition and Turbulence, CFD, Supersonic/Hypersonic Flows, Biofluids
- ✦ **C.S.Upadhyay** : Solid Mechanics, FEM, Damage Mechanics
- ✦ **C.Venkatesan**: Helicopter Dynamics and Aeroelasticity, Smart Structures, Autonomous Mini Helicopter
- ✦ **D.Yadav** : Structural Dynamics, Stochastic Processes, Optimization
- ✦ **D.P.Mishra** : Combustion, Reacting Flow(CFD), Heat Transfer, Atomization
- ✦ **D.Das** : Experimental Fluid Dynamics, Unsteady Aerodynamics, Stability & Transition, Aeroacoustics
- ✦ **E.Rathakrishnan** : Gas Dynamics
- ✦ **K.Ghosh** : Aerodynamics, Wind Energy, Missile Aerodynamics & Control
- ✦ **K.Poddar** : Aerodynamics, Turbulence, Low and High speed Flows
- ✦ **M.T.Nair** : Aerodynamics, CFD, Hypersonics, Optimization (Visiting)
- ✦ **P.M. Mohite** : Damage mechanics of composites, composites, FEM (Visiting)
- ✦ **R.K.Sullerey** : Aerospace Propulsion, Turbo-machinery, active and passive control of internal flows (on leave)
- ✦ **S.Mittal** : Aerodynamics, CFD, FEM, Shape Optimization, Flow instabilities
- ✦ **S.Mahesh** : Stochastic Fracture Mechanics
- ✦ **S.Kamle** : Experimental Stress Analysis, Smart Materials
- ✦ **T.K.Sengupta** : Transition and Turbulence, Aerodynamics, CFD & CAA
- ✦ **T.G. Pai** : Flight Mechanics, Wind Tunnel (Visiting)
- ✦ **V.Gupta** : Aerodynamics, High speed Flows, Noise Control (on leave)



Jet Test Facility

Contact
Head
head_aero@iitk.ac.in
Aerospace Engineering Department
Indian Institute of Technology Kanpur
Kanpur-208016
INDIA
Ph: 91-512-2597626/2597561
Fax: 91-512-2597561
Website: www.iitk.ac.in/aero



Schweizer 2-22 Glider Flight Lab