von KARMAN INSTITUTE
FOR FLUID DYNAMICS

Research topics for

VKI Research Master /Short Training/Master Thesis Programmes

ENVIRONMENTAL AND APPLIED FLUID DYNAMICS DEPARTMENT

1. Machine Learning in Fluid Dynamics [NUM, EXP, THEORICAL]
2. Non-intrusive and intrusive instrumentation development for single and multiphase flows [EXP]
3. Data-driven CFD model development for complex turbulent flows [NUM]
4. Thermal-hydraulics of liquid metal flows for metallurgy and nuclear applications [NUM, EXP, THEORETICAL]
5. Fluid dynamics in industrial processes [NUM, EXP]
6. Flow Induced Vibration and mitigation [NUM, EXP, THEORICAL]
7. Additive manufacturing in heat exchangers [NUM, EXP]
8. Multiphase modelling and simulations for innovative systems [NUM, EXP, THEORETICAL]
9. Wind and Wave loading on floating and fixed structures [NUM, EXP, THEORETICAL]
10. Multiphase heat transfer in low Global Warming Potential (GWP) refrigerants [NUM, EXP]
11. Anti- and de-icing techniques for airfoils [EXP, NUM]
12. Pollutant dispersion in atmospheres [NUM, EXP]
13. Effect of wind and storm on built environment and city life [NUM]
14. Weather Research and Forecasting [NUM]
15. Wind turbine and wind farm wake modeling [NUM]
16. Aeroacoustics in ground/air transportation, wind energy and industrial systems [NUM,EXP]
17. Aerodynamics of Unmanned Air Systems and novel aircraft architectures (including Urban Air Mobility) [NUM,EXP]

TURBOMACHINERY AND PROPULSION DEPARTMENT

1. Experimental aerodynamics and heat-transfer of axial turbines (EXP)
2. Experimental aerodynamics and heat transfer of axial compressors (EXP)

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3. Numerical simulation and multi-disciplinary optimization of turbomachinery components (NUM)
4. Design methods for turbomachinery concepts and components (NUM, THEORY)
5. Hypersonic and supersonic propulsion systems (NUM, THEORY)
6. Hybrid electric propulsion (NUM, THEORY)
7. Rotating detonation engine technology and pressure-gain combustion (NUM)
8. Quantum computing algorithms for fluid dynamics (NUM, THEORY)
9. Turbomachinery aeroelasticity and fluid-structure interaction (NUM, EXP)
10. Turbulence and laminar-turbulent transition in compressible turbomachinery and propulsion flows (EXP, THEORY, NUM)
11. Machine learning for turbomachinery, numerical modelling and design optimization (THEORY, NUM)
12. Development and application of measurement techniques for turbomachinery flows (EXP, THEORY)

AERONAUTICS AND AEROSPACE DEPARTMENT

Rarefied and Plasma Flows

1. CubeSat: payloads,
2. Experimental orbital flow reproduction and material testing in Drag-On: Plasma diagnostics (Electrostatic probes, Momentum flux Probes, Optical techniques), Material exposure tests, ABEP system.
3. Rarefied flow modeling and simulation: direct simulation Monte Carlo methods, moment methods, direct Boltzmann solvers, panel methods
4. Plasma flows modeling and simulation:
   Particle in Cell methods, fluid methods, collisional-radiative models
   Lattice-Boltzmann methods
   Plasma sheath modeling
   Electric propulsion modeling
   Space debris modeling
   Meteor modeling

Aerothermodynamics

5. Hypersonic Aerodynamics and Aerothermodynamics (launchers, spacecrafts, cruise vehicles, space debris...)

6. Planetary Reentry simulations (Trajectories, Reentry strategy, vehicle stability, recovery approach, …)
7. Physics of high-speed flows (Boundary layer stability and laminar-to-turbulent transition, Shock-wave boundary layer interactions ...)
8. Wind tunnel testing capabilities (intrusive probes and non-intrusive measurement techniques, flow visualization, nozzle design...)

Aerothermochemistry

9. Experimental reentry flow reproduction and material testing in Plasmatron: Material characterization, material demise, thermal protection, sub- and supersonic plasma flow characterization, trajectory reproduction
10. Numerical reentry flow reproduction and material simulations: Material characterization, material demise, thermal protection, sub- and supersonic plasma flow simulation and characterization, trajectory reproduction, macro-, meso-, microscale material simulations
11. Development of experimental measurement technics in high-enthalpy flows: New imaging methods, 3D imaging, Thermal imaging, Spectroscopy, (fast response) Pressure measurements
12. Design/development of reentry experiment: Demise testing platform, reentry satellite, reusable satellite,…

AR Numerical

13. High-Order Methods for Flow Simulation: Discontinuous Galerkin methods, development of solver technology (time marching, relaxation methods, preconditioning), tools for hypersonic flow (limiting, positivity, shock capturing methods)
14. Mesh Adaptation Methods: Anisotropic adaptation, metric-based adaptation, adjoint-based goal oriented adaptation, hybrid-mesh adaptation, optimization methods for metric fields
15. Model Development: Efficient solvers for inductively coupled plasma, MHD, high-enthalpy flows in chemical and / or thermal nonequilibrium
16. Shape Optimization: Adjoint-based shape optimization, shape derivatives, drag / heat flux minimization
17. Automatic Mesh Generation: Hybrid mesh generation using open source software (boundary layer generation, structured block within shock layer,…)

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