Gaurav Kumar

302, National Wind Tunnel Facility Building
Indian Institute of Technology, Kanpur
Kanpur, India, 208016

Mobile No.: +91 (821) 077 3184
Email-id: gauravkr@iitk.ac.in
Homepage: gauravkumar463.github.io

ACADEMIC DETAILS

Degree	Department	Institute	Year	CPI
Doctor of Philosophy	Aerospace Engineering	IIT Kanpur	2016 - Present	9.0/10.0
Master of Technology	Aerospace Engineering	IIT Kanpur	2011 - 2016	10.0/10.0
Bachelor of Technology	Aerospace Engineering	IIT Kanpur	2011 - 2016	7.7/10.0
Intermediate (Class XII)	CBSE	St. Josephs Public School	2009 - 2011	90.2%
Matriculation (Class X)	CBSE	S D S Vidya Mandir	2005 - 2009	94.8%

FIELDS OF INTEREST

- Numerical methods, Turbulence, High speed flows, Fluid-structure interaction, Reduced order modeling

JOURNAL PUBLICATIONS

- **Gaurav Kumar** and Ashoke De. "Role of corner flow separation in unsteady dynamics of hypersonic flow over a double wedge geometry", submitted to Physics of Fluids (December 14, 2020)
- **Gaurav Kumar** and Ashoke De. "An improved density based compressible flow solver in OpenFOAM for unsteady flow calculations", (Book chapter accepted for publication in "Current Trends in Fluid Dynamics by Springer" (2021))
- Mitesh Thakor, **Gaurav Kumar**, Debopam Das, and Ashoke De. "Investigation of asymmetrically pitching airfoil at high reduced frequency." Physics of Fluids 32.5 (2020): 053607
- Alok Mishra, **Gaurav Kumar**, and Ashoke De. "Prediction of separation induced transition on thick airfoil using non-linear URANS based turbulence model." Journal of Mechanical Science and Technology 33.5 (2019): 2169-2180
- **Gaurav Kumar**, Ashoke De, and Harish Gopalan. "Investigation of flow structures in a turbulent separating flow using hybrid RANS-LES model." International Journal of Numerical Methods for Heat & Fluid Flow 27.7 (2017): 1430-1450
- **Kumar, G.**, Lakshmanan, S. K., Gopalan, H., & De, A. "Investigation of the sensitivity of turbulent closures and coupling of hybrid RANS-LES models for predicting flow fields with separation and reattachment." International Journal for Numerical Methods in Fluids 83.12 (2017): 917-939

CONFERENCE PROCEEDINGS

- **Gaurav Kumar** and Ashoke De. "Self-induced oscillations of the shock structures in a hypersonic flow over double wedge", to be presented at 25^{th} International Congress of Theoretical and Applied Mechanics (25^{th} ICTAM), August 23 - 28, 2021
- **Gaurav Kumar**, Ashoke De "Effect of turbulence in unsteady shock interaction and heat transfer mechanism in a hypersonic flow over double wedge", "32^{nd} International Symposium on Shock Waves", Conference proceedings ISSW32, 2019
- **Gaurav Kumar**, Ashoke De "A density based compressible flow solver in OpenFOAM with Mach number preconditioning and Low-diffusive Flux Splitting Scheme" 7^{th} International and 45^{th} National Conference on Fluid Mechanics and Fluid Power (FMFP2018), Mumbai, India, 2018
- **Gaurav Kumar**, Harish Gopalan, Dominic Chandar, Vinh-Tan Nguyen, and Ashoke De. "Verification of length scale effects on solution accuracy of hybrid RANS-LES methods." ASME 2016, 35^{th} International Conference on Ocean, Offshore and Arctic Engineering. American Society of Mechanical Engineers, 2016
- **Kumar, G.**, Lakshmanan, S. K., Gopalan, H., & De, A. "Comparative study of hybrid RANS-LES models for separated flows." AIP Conference Proceedings. Vol. 1738. No. 1. AIP Publishing, 2016

PH.D THESIS

- **Numerical Study of Viscous Interaction between Shock Waves and Separation Region over a Double Wedge in Hypersonic Flows** *(Supervisor: Prof. Ashoke De)*
  - Designed and implemented a new density based compressible flow solver in an open-source CFD platform called OpenFOAM
  - Demonstrated the improved stability and accuracy of the new solver through various test cases involving shock waves, boundary layer and separated flows
  - Studied the hypersonic flow over double wedge configuration in detail to understand unsteady interaction between shock-waves and boundary layer or separation region
  - Studied the effect of the local heating of the body using conjugate heat transfer during shock incidence and reflection from the wedge
  - Added numerically more accurate flow physics knowledge to the available published literature
  - Identified an important configuration for shock reflection in order to produce unsteady pulsating flows

M.TECH THESIS

- **Investigation of Turbulent Separated Flow using Hybrid RANS-LES Models**
  (Supervisors: Prof. Ashoke De, Dr. Harish Gopalan)
  - Introduced a non-linear blended turbulence modeling framework for computational fluid dynamics
  - Performed a comparative study to investigate the sensitivity of hybrid RANS-LES models given the choices of RANS and LES models using various interface switching criteria
  - Investigated unsteady flow structures in the turbulent separated flows to examine the effectiveness of hybrid RANS-LES models in the prediction of an accurate instantaneous flow field
  - Demonstrated that the newly developed hybrid RANS-LES model produces a flow field which is more accurate and less grid-sensitive for a given grid resolution among various hybrid turbulence models

INTERNSHIPS AND MAJOR PROJECTS

- **Hindustan Aeronautical Limited, India** (Research Assistant, Oct - Dec, 2016)
  (Supervisor: Prof. Bishakh Bhattacharya, Professor, IIT Kanpur)
  - **Objective:** Simulation of Cabin Pressure Control System of an aircraft
    - Developed a computer program to simulate the on and off-design performance of a cabin pressure control system
    - Identified optimal design parameters for constraining the off-design performance of the cabin pressurization system within the regulations of FAA

- **Institute of High Performance Computing, Singapore** (Research Assistant, Jan - May, 2016)
  (Supervisors: Dr. Harish Gopalan, Dr. Vinh-Tan Nguyen, Scientist)
  - **Objective:** Numerical simulation of flow past tandem square columns at high Reynolds number using hybrid RANS-LES models
    - Carried out the CFD computation of flow past tandem square columns using OpenFOAM platform
    - Applied the reduced order modeling techniques such as Proper Orthogonal Decomposition (POD), Dynamic Mode Decomposition (DMD) and linear regression to find out a simple force prediction method on tandem column configurations

- **National Aerospace Laboratories, Bangalore, India** (Research Assistant, May - July, 2014)
  (Supervisor: Dr. S. Venkat Iyengar, Senior Scientist, Propulsion Division)
  - **Objective:** Development of endothermic fuel platform for scramjet engines and to probe Technology Readiness Levels (TRL) achieved by different countries
    - Proposed a detailed roadmap towards the development of endothermic fuel technology for incorporation in hypersonic scramjet air vehicle
    - Recommended a set of experiments and facilities required in order to realize a TRL of 4

COURSE PROJECTS

- **Rocket Engine Design** (Spring, 2015)
  (Instructor: Prof. D. P. Mishra, Aerospace Engineering, IIT Kanpur)
  - Designed a theoretical 3-stage rocket engine with solid and liquid propellant to transfer a payload to lower lunar orbit
  - Performed a detailed analysis of the design based on concepts of aero-thermodynamics and mechanical design
  - Suggested guidelines for better understanding of processes involved in the multistage rocket engine design
- **Aircraft Design** (Fall, 2015)
  (Instructor: Prof. A. Tewari, Aerospace Engineering, IIT Kanpur)
  - Designed a turboprop transport cargo aircraft meeting specific constraints of range, cruise speed, fuel efficiency and payload
  - Executed performance and stability analysis to establish all the safety requirements for the aircraft
  - Designed scaled CAD drawings of the aircraft with the parameters calculated in the design process
- **Aeromodel Design and Fabrication** (Spring, 2014)
  (Instructor: Prof. S. Kamle, Aerospace Engineering, IIT Kanpur)
  - Built a Remote-Controlled plane capable of performing multiple maneuvers and having high lift to drag ratio
  - Enhanced energy efficiency and structural rigidity by using various fabrication materials
  - Extended glide endurance by iterative refinement of the RC plane design

WORKSHOP ATTENDED

- "Immersed Boundary Methods for Turbulent Incompressible Flows" organised under "Global Initiative for Academic Networks" by IIT Kharagpur, December 18 - 22, 2017

JOURNAL REVIEWER

- Physics of Fluids
- International Journal of Numerical Methods for Heat and Fluid Flow

TEACHING EXPERIENCE

- **Course tutor:** Introduction to Fluid Mechanics and Rate Processes (*ESO204, IIT Kanpur; Fall, 2020*)
- **Teaching assistant:** Introduction to Finite Volume Method II (*under NPTEL initiative; Spring 2019*)
- **Teaching assistant:** Thermodynamics (ESO201; Fall 2019), Engineering Drawing (TA101; Spring 2018), Fluid Mechanics and Rate Processes (ESO204; Spring 2017), Technical Communication (AE401; Fall 2015)

SKILLS

- **Languages:** English (Professional working proficiency), Hindi (Native mother tongue), German (Elementary proficiency), Chinese (Elementary proficiency)
- **Programming & Scripting**: C/C++, Python, R, MATLAB, GNU Octave, gnuplot, BASH, LaTeX
- **Softwares & Tools**: Ansys CFD Tools, OpenFOAM CFD toolbox, Tecplot, Paraview, AutoCAD, MS office
- **Operating systems:** Windows , Linux on most distributions

EXTRA-CURRICULAR

- Playing Tennis, running, swimming, reading and traveling