Gaurav Kumar

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Education

- Indian Institute of Technology, Kanpur, India

  ◇ Doctor of Philosophy   July 2016 - Present
  ◇ Grades: 9.0/10.0

- Indian Institute of Technology, Kanpur, India

  ◇ B.Tech - M.Tech Dual Degree   July 2011 - June 2016
  ◇ Grades: PG- 10.0/10.0, UG- 7.7/10.0

Research Interest

- Computational Fluid Dynamics
- Turbulence modeling
- High speed flows
- Fluid-Structure interaction
- Reduced order modeling
- Wind energy systems

Journal Publications

Article under Review

- **Gaurav Kumar** and Ashoke De. "Numerical study of viscous interaction between shock waves and separation region over a double wedge", submitted to Journal of Fluid Mechanics (March 10, 2020).
- Mitesh Thakor, **Gaurav Kumar**, Debopam Das, and Ashoke De. "Numerical investigation of low Reynolds number airfoil undergoing asymmetric sinusoidal pitching motion at a high reduced frequency", submitted to Physics of Fluids (Accepted for publication).
- **Gaurav Kumar** and Ashoke De. "An improved density based compressible flow solver in OpenFOAM for unsteady flow calculations", (Book chapter submitted to "Current Trends in Fluid Dynamics by Springer").

Refereed Articles

- 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.

Refereed 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 25th International Congress of Theoretical and Applied Mechanics (25th 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", "32nd 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" 7th International and 45th 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, 35th 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
- **Indian Institute of Technology, Kanpur, India**   **Aug, 2016 - Present**

    ◇ **Project title**: Numerical Study of Viscous Interaction between Shock Waves and Separation Region over a Double Wedge
    ◇ **Advisor**: 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 unsteady test cases involving shock waves, boundary layers and separated flows.
    * Studied the hypersonic flow over double wedge configuration in detail to understand unsteady interaction between shock-waves and boundary layer/separation region.
    * Identified a window of geometric parameter which is crucial in avoiding design conditions which could result in catastrophic failures of hypersonic flights.

M.Tech Thesis
- **Indian Institute of Technology, Kanpur, India**   **May, 2015 - May, 2016**

    ◇ **Project title**: Investigation of Turbulent Separated Flow using Hybrid RANS-LES Models
    ◇ **Advisor**: 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 to the choice of RANS models, LES models and interface switching criteria.
    * Investigated unsteady flow structures in the tubulent separated flows to examine the effectiveness of hybrid RANS-LES models in the prediction of an accurate instantaneous flow fields.
    * Demonstrated that the newly developed hybrid RANS-LES model can produce improved results at a very economical cost as compared to the previous turbulence models.

Internships
- **Institute of High Performance Computing, Singapore**   **Jan - May, 2016**
    ◇ **Project title**: Numerical simulation of flow past tandem square columns at high Reynolds number using hybrid RANS-LES models
    ◇ **Advisor**: Dr. Harish Gopalan, Dr. Vinh-Tan Nguyen
    * Carried out the numerical simulations for flow past tandem square columns at high Reynolds number using hybrid RANS-LES models.
    * Applied the reduced order modeling techniques to find out a simple force prediction method on such tandem column configurations.

- **National Aerospace Laboratories, Bangalore, India**   **May - July, 2014**
    ◇ **Project title**: Development of Endothermic Fuel Platform for Scramjet Engines and To probe Technology Readiness Levels Achieved by Different Countries.
    ◇ **Advisor**: Dr. S. Venkat Iyengar, Senior Scientist, Propulsion Division
    * Conducted a literature survey on the progress of Endothermic Fuel Technology in different countries for its application in Scramjet Engine and assigned a Technology Readiness Level to the previous works on the basis of available literature.
    * Studied the fundamental concepts about thermal cracking of long chain hydrocarbon fuels, its application in cooling of hypersonic vehicles and the problems associated with its application in scramjet engines in great detail.

  * Recommended a detailed roadmap to develop this technology and to incorporate it in hypersonic scramjet air vehicle and a set of experiments required to be conducted and facilities required to be established in order to realize a TRL of 4 had been proposed.

Industrial Project

- **Hindustan Aeronautical Limited, India**   **Oct - Dec, 2016**
  - ◇ **Project title**: Numerical Simulation of Cabin Pressure Control System
  - ◇ **Advisor**: Prof. Bishakh Bhattacharya, Mechanical Engineering, IIT Kanpur
    * Developed a computer program to simulate the on and off-design performance of a cabin pressure control system.
    * Performed parametric study of design options to study variation in simulated cabin pressure with altitude while climb and descent of flight.
    * Identified optimal design parameters for constraining the off-design performance of the cabin pressurization system within the regulations of FAA.

Course Projects

- **Rocket Engine Design**   **July - Nov, 2014**
  - ◇ **Project title**: Rocket Engine Design to Transfer a Payload to Lower Lunar Orbit
  - ◇ **Advisor**: Prof. D. P. Mishra, Aerospace Engineering, IIT Kanpur
    * Theoreticaly designed a three stage rocket engine to transfer a payload to lower lunar orbit.
    * Conducted a detailed analysis for each step involved in the design based on the theory of Aero-thermodynamics of rocket engine and mechanical design.
    * Laid down a road map as a guide for better understanding the rocket engine design process.

- **Aircraft Design**   **July - Nov, 2014**
  - ◇ **Project title**: Design of a Turboprop Transport Cargo Aircraft
  - ◇ **Advisor**: Prof. A. Tewari, Aerospace Engineering, IIT Kanpur
    * Designed a turboprop transport cargo aircraft satisfying specific requirements of range, cruise speed, fuel efficiency, pay load, etc.
    * Carried out a performance analysis and stability analysis to verify if the aircraft meets all safety requirements.
    * Sketched a scaled CAD drawings of the designed aircraft With the calculated data.

Workshop Attended

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

Journals Reviewer

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

Teaching Skills

- Teaching Assistant for **Introduction to Finite Volume Method II** (under NPTEL initiative) course, *Spring 2019*
- Teaching Assistant for **Thermodynamics (ESO201)** course, *Fall 2018*
- Teaching Assistant for **Engineering Drawing (TA101)** course, *Fall 2017*
- Teaching Assistant for **Fluid Mechanics and Rate Processes (ESO204)** course, *Spring 2017*
- Teaching Assistant for **Technical Communication (AE401A)** course, *Fall 2015*

Relevant Courses

- Computational Fluid Dynamics
- Finite Element & Finite Volume Methods
- Turbulence
- Transition to Turbulence
- Boundary Layer Theory
- Turbulent Combustion
- Molecular & High Temperature Gas Dynamics
- Rocket Engine Design
- Aeroelasticity
- Aircraft Design and Aeromodeling

Languages

- **English**: Professional working proficiency
- **Hindi**: Native mother tongue
- **German**: Elementary proficiency
- **Chinese**: Elementary proficiency

Technical Skills

- **Programming Languages**: C/C++, R, HTML/HTML5, CSS/CSS3
- **Softwares & Tools**: Ansys CFD Tools, OpenFOAM CFD toolbox, Tecplot, Paraview, gnuplot, AutoCAD, LabVIEW, GasTurb, MATLAB, MS office
- **Operating Systems**: Windows and Linux on most distributions