

Kanak Agarwal

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EDUCATION

MANIPAL INSTITUTE OF TECHNOLOGY | B.TECH AERONAUTICAL ENGINEERING

2021 - Present | Manipal, Karnataka, India

Expected Year of Graduation: 2025

CGPA: 8.40

LALAJI MEMORIAL OMEGA INTERNATIONAL SCHOOL | CLASS 12 (CBSE), CS MAJOR

2021 | Chennai, Tamil Nadu, India

Grade: 91.2%

LALAJI MEMORIAL OMEGA INTERNATIONAL SCHOOL | CLASS 10 (CBSE)

2019 | Chennai, Tamil Nadu, India

Grade: 90.4%

PUBLICATIONS

CONCEPTUAL DESIGN OF A SOLAR-POWERED UAV FOR THE STUDY OF THE MARTIAN PLANETARY BOUNDARY LAYER (MANUSCRIPT UNDER PREPARATION)

This study corresponds to the work carried out as part of the seventh edition of the National Aerospace Conceptual Design Challenge (NACDeC) where we secured the second position out of 45 teams. It aims to develop and propose a fully-fledged conceptual UAV for the planetary boundary layer (PBL) study of the lower stratum of the Martian atmosphere while maximising the number of sorties in a sol. The region of study for the proposed UAV would be the roughness layer corresponding to the initial 100 m above the Martian surface. We intend to submit this paper to the AIAA journal "Journal of Aircraft".

CFD-BASED EVALUATION OF AIRSHIP DESIGNS: A STUDY OF CONVENTIONAL, BI-LOBED, AND TRI-LOBED CONFIGURATIONS IN OPENFOAM® (MANUSCRIPT UNDER PREPARATION)

This study uses OpenFOAM® to analyse the aerodynamic characteristics of both conventional and multi-lobed airships. This study's primary objectives are to compare conventional airships' aerodynamic performance with multi-lobed airships and to examine the differences in their lift-to-drag ratios. Additionally, the effects of specific design parameters, such as the shape of the hull, fin configurations, and lobe arrangements, on drag and lift generation are analysed. Further, the effects of different turbulence models on the results obtained are also examined. We intend to submit this paper to the journal "Computers & Fluids".

DNS OF BOUYANT VORTEX DIPOLES (MANUSCRIPT UNDER PREPARATION)

This paper corresponds to my research internship under Dr. A Sameen at the Indian Institute of Technology (IIT), Madras. This paper explores the evolution of a Buoyant Vortex Dipole using pseudo-spectral methods and addresses the varied effects of Ra , Pr and Re . Based on different morphological features observed in the evolution of temperature and vorticity, several regimes of evolution of a buoyant vortex dipole were also identified. We intend to submit this paper to the journal "Physics of Fluids".

MATLAB-ENHANCED WING DESIGN AND AERODYNAMIC MODELING (UNDER REVIEW)

This paper corresponds to my research project with the same title. The extended abstract of this paper has been submitted to the 10th Symposium on Applied Aerodynamics and Design of Aerospace Vehicles & SPICES Workshop organised by the Indian Space Research Organisation (ISRO) and is currently under review.

A MATLAB GUI-BASED APPROACH TO WING DESIGN AND AERODYNAMIC PERFORMANCE EVALUATION (ACCEPTED)

This study presents a MATLAB-based application developed for the preliminary design and aerodynamic analysis of varying wing geometries using the NACA 4 and 5-digit series airfoils. The full paper has been submitted to the International Conference on Futuristic Advances in Mechatronics Engineering for Aerospace and Defence (ICFAMEAD-2024) and has been accepted. The conference

was held on the 4th & 5th of October 2024. Our paper was declared the best paper in the Design Engineering track at the conference.

A COMPREHENSIVE DATASET OF THE AERODYNAMIC AND GEOMETRIC COEFFICIENTS OF AIRFOILS IN THE PUBLIC DOMAIN

The dataset of the aerodynamic and geometric coefficients of 2900 airfoils obtained using the automated CFD framework developed was published by the MDPI Data Journal. The paper can be accessed [here](#). I primarily worked on the automation and parallelisation process of the CFD simulations. While using an 8-core computer system (only 10 threads were used), the average CFD simulation took approximately 15 minutes for near convergence. Subsequently, carrying out the required number of simulations ($2900 \times 13 \text{ AoA} = 37700$ individual simulations) would be unrealistic. It was estimated that running the simulations in series for one AoA would take approximately 31 days. This would translate into 403 days for 13 angles of attack. Due to the sheer amount of time it would take to run simulations for 2900 airfoils at a single AoA, it was then decided to parallelise the simulation process.

The simulations were then process-parallelised as this was deemed more effective when compared to traditional mesh decomposition. The airfoil database was divided into parts, allowing for simultaneous runs of one case per sub-database. This setup ensured that several simulations were operational concurrently. The scheduling and management of these subprocesses were accomplished using bash scripts. This parallelisation process resulted in a speedup of roughly 21X, which led to a run time of 1.5 days as opposed to 31 days for a single AoA.

RESEARCH EXPERIENCE

STUDY OF VORTEX RINGS (IITM)

December 2023 - Present | Chennai, Tamil Nadu, India

Under Dr. A Sameen at the Theoretical and Computational Fluid Dynamics Laboratory (TCFD) at the Indian Institute of Technology (IIT), Madras, I'm studying the temporal evolution of vortex rings using pseudo-spectral methods implemented in Dedalus, an open-source Python-based framework built specifically for spectral analyses. The Dedalus framework is MPI-parallelised. I am currently validating the numerical setup of the 3-D extension (vortex ring) of our previous work on the evolution of buoyant vortex dipoles.

APPLICATION BASED AIRFOIL GENERATION

July 2022 - April 2024 | Manipal, Karnataka, India

Worked on a research project under Dr. Manikandan Murugiah to develop a computational model for application-based airfoil generation (based on the required C_l and C_d values). Automated the CFD process, and a database of the aerodynamic and geometric coefficients of 2900 airfoils was generated using OpenFOAM and Bash scripting in Linux.

MATLAB-ENHANCED WING DESIGN AND AERODYNAMIC MODELING

December 2023 - February 2024 | Manipal, Karnataka, India

This research project was done under Dr. Manikandan Murugiah and aimed to develop a MATLAB-based framework for efficiently designing intricate wing surfaces, offering an alternative to the cumbersome and skill-intensive CAD software processes. This method facilitates the automated creation of '.stl' files for wings of various dimensions, allowing for the integration of customisable geometrical features such as twist, dihedral, and sweep. It uniquely enables the incorporation of both geometric and aerodynamic twists, with the capability to produce varied root and tip airfoils internally. The software is compatible with multiple NACA airfoil series, extending support to both the CST and PARSEC parameterisation methods.

RESEARCH INTERESTS

- Aerodynamics
- Aircraft Design
- Fluid Dynamics
- Vortex Dynamics
- Fluid-Structure Interaction
- Supersonic and Hypersonic Flows
- High Performance Computing (HPC)
- Computational Fluid Dynamics (CFD)
- Turbulent Flows and Turbulence Modeling

OTHER PROJECTS

NATIONAL AEROSPACE CONCEPTUAL DESIGN COMPETITION (NACDEC)

September 2023 - September 2024 | Manipal, Karnataka, India

Secured second place in the seventh edition of the National Aerospace Conceptual Design Competition (NACDeC) organised in collaboration with the Indian Space Research Organisation (ISRO) out of 45 teams that participated. The problem statement called for the conceptual design and sizing of a Martian Unmanned Aerial Vehicle (UAV) with an all-up weight of 70 kg. The UAV would study the Martian planetary boundary layer corresponding to the lower stratum of the Martian atmosphere (0-100 m).

STATIC STABILITY ANALYSIS OF THE CESSNA T-37

October 2023 | Manipal, Karnataka, India

Carried out a detailed static stability analysis of the Cessna T-37 as a part of my coursework in the academic year 2023-24 (Flight Dynamics - FD) at the Manipal Institute of Technology, Manipal, Karnataka, India.

CFD COMPETITION (ICCMEH 2023)

July 2023 - August 2023 | Manipal, Karnataka, India

Participated in the CFD competition organised as a part of ICCMEH 2023. The problem statement dealt with the optimisation of the NACA 4412 airfoil for maximum aerodynamic efficiency constrained to the specified operating conditions and several shape constraints. A multi-faceted approach was taken to solving the given problem. A mesh validation study was conducted to verify the quality of the mesh. Initially, a parametric sweep was carried out in Ansys Fluent to evaluate the scope of the problem. Based on this, an optimisation using CST coefficients was conducted by integrating MATLAB with XFOIL. This was achieved using a genetic algorithm developed using MATLAB. The optimised aerofoil thus achieved was subjected to a parametric sweep to validate and compile the resulting aerofoil's characteristics. We secured the third rank and were commended on the quality of our work.

PERFORMANCE ANALYSIS OF THE AIRBUS A380-800M

February 2023 - May 2023 | Manipal, Karnataka, India

Carried out a detailed performance analysis of the Airbus A380-800M as a part of my coursework in the academic year 2022-23 (Flight Mechanics - FM) at the Manipal Institute of Technology, Manipal, Karnataka, India. My professor praised the quality of the report.

E-SHOPPING PLATFORM

2021 | Chennai, Tamil Nadu, India

Successfully developed a CLI-based E-shopping interface using Python and MySQL as a part of my Class 12 final project.

SKILLS

TECHNICAL

- C
- Python
- MATLAB
- LaTeX
- HTML
- XML
- MySQL
- OpenFOAM
- ParaView
- Ansys
- COMSOL
- XFLR5
- XFOIL
- Linux
- Solidworks
- Fusion360
- AutoCAD
- CATIA
- 3DEXperience
- OpenVSP
- Simulink
- Photoshop
- Illustrator
- Lightroom
- Canva
- Microsoft Office
- High Performance Computing (HPC)
- Tecplot360
- PBS
- Slurm
- Git & GitHub
- XMGrace
- Shell Scripting
- OpenMPI

OTHER

- Expert communication and presentation skills.

OTHER EXPERIENCE

RESEARCH SOCIETY MIT | Co-EXPERTISE HEAD

September 2023 - September 2024 | Manipal, Karnataka, India

The Research Society MIT is Manipal's official student research body that works on an array of research projects, covering a broad span of fields, from artificial intelligence and robotics to nanotechnology and immunology. I was the co-expertise head of the aerospace, aeronautics, and material sciences domains.

IE AEROSPACE | ADVISORY BOARD MEMBER

September 2023 - September 2024 | Manipal, Karnataka, India

IE Aerospace is a students' chapter affiliated with the Institution of Engineers, India. Their mission is to spread awareness about the booming field of aerospace engineering.

MANO AIRCRAFT PRIVATE LIMITED | INTERN

June 2023 | Coimbatore, Tamil Nadu, India

Learnt and applied several composite manufacturing techniques during my internship. Further, I developed a Python script to automate the pre-composite manufacturing processes. I also created a market survey outreach form as part of a market analysis.

AEROMIT | JUNIOR AERODYNAMICS ENGINEER

December 2021 - April 2023 | Manipal, Karnataka, India

AeroMIT is the official aeromodelling and aerial robotics team of the Manipal Academy Of Higher Education. The project was founded 14 years ago, in 2009, and now has grown into a thriving team of around 40 interdisciplinary undergraduate students from MIT, Manipal. I was part of the Aerodynamics subsystem at AeroMIT, and my responsibilities included writing the design reports for competitions and designing RC aircraft for various mission requirements based on fundamental aerodynamic principles.

ACHIEVEMENTS

BEST PAPER IN THE DESIGN ENGINEERING TRACK AT ICFAMEAD 2024

October 2024 | Pune, Maharashtra, India

Our paper titled, 'A MATLAB GUI Based Approach to Wing Design and Performance Evaluation' was declared the best paper out of 40 papers in the Design Engineering Track at the International Conference on Futuristic Advances in Mechatronics Engineering for Aerospace and Defence (ICFAMEAD) 2024.

NACDEC VII

August 2023 | Bangalore, Karnataka, India

Secured 2nd position (Team FlightForge) out of 45 teams in the National Aerospace Conceptual Design Competition (NACDeC) organised in collaboration with the Indian Space Research Organisation (ISRO).

ICCMEH 2023

August 2023 | Manipal, Karnataka, India

Secured the third rank for our submission to the CFD competition held as a part of ICCMEH 2023.

SAE AERO DESIGN

March 2023 | Lakeland, Florida, USA

Participated in the SAE Aero Design East 2023 held at Lakeland, Florida, USA, as a part of my tenure at AeroMIT. We were awarded second place for the Design Report and secured fourth rank overall.

PAPER PRESENTATION

December 2022 | Manipal, Karnataka, India

Was awarded the first prize in the Paper Presentation event as part of the Tech Tatva '22. I presented a research paper on the viability of Methane as a fuel for liquid rocket engines.