PRANAV THAKARE

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EDUCATION

Ph.D. - Aerospace Engineering (Aerodynamics) July, 2016- Nov., 2022
Indian Institute of Technology Bombay, India **CGPA: 8.88/10**

Maters of Technology - Aerospace Engineering (Propulsion) July, 2014-June, 2016
Indian Institute of Technology Bombay, India **CGPA: 8.35/10**

Bachelor of Technology - Mechanical Engineering Aug., 2010- May, 2014
YCCE, Nagpur University, Maharashtra, India **CGPA: 8.1/10**

Higher Secondary Certification (HSC) - Electronics May, 2010
Maharashtra Board **87.33 %**

Secondary School Certification (SSC) June, 2008
Maharashtra Board **88.92 %**

RESEARCH INTEREST

High-speed compressible flow physics: shock-turbulence interaction, jet acoustics and boundary layer transition (mathematical modeling, CFD and experiments); Physics-informed and data-driven (& machine learning) approaches for flow analysis, predictive modeling, and control.

RESEARCH EXPERIENCE

Postdoctoral Research Associate (ANRF-NPDF) April, 24 - Oct., 25; Nov. 2025 - June, 2026.
Dept. of Aerospace Engineering, Indian Institute of Science (IISc), Bengaluru, India.

- **Project**: *Development of Physics-Informed Semi-Empirical Model for Hypersonic Boundary Layer Transition Prediction and Control (**research component associated with the project of strategic national relevance**).*
- **Mentor**: Prof. Duvvuri Subrahmanyam
  1. Conducting experiments to study both natural and trip-induced hypersonic boundary-layer transition over a flat plate at the Roddam Narasimha Hypersonic Wind Tunnel (RNHWT) facility at IISc.
  2. Using pressure measurements and infrared thermography to examine disturbance amplification and determine transition onset.
  3. Establishing a physics-based semi-empirical correlation between transition location and trip geometry.
  4. Developing a model to predict the optimal trip geometry required to achieve transition at a specified downstream location.

- **Project**: *Physics-Informed Machine Learning Framework for Reconstruction of High-Speed Aerodynamic Flow Fields (**ANRF-NPDF project**).*
- **Mentor**: Prof. Duvvuri Subrahmanyam
  1. Developing a hybrid physics-informed framework that combines Schlieren-based Momentum Potential Theory (MPT) with physics-informed neural networks (PINNs) / Hidden Fluid Mechanics (HFM) for flow-field reconstruction.
  2. Using time-resolved Schlieren data and sparse experimental measurements from sonic and multi-sonic jet configurations to infer pressure, velocity, and density fields.
  3. Extracting acoustic, vortical, and thermal components of the flow from limited observations to identify the dominant flow mechanisms.

4. Extending the methodology to complex high-speed aerodynamic problems where direct measurements are sparse, including shock-dominated and transition-related flows.

Postdoctoral Research Associate Jan., 2023 - March, 2024
Dept. of Mechanical & Aerospace Eng., The Ohio State University, Columbus, USA

- **Project**: *Active Flow Control of Supersonic Shear Layers in Rectangular Multistream Nozzle.*
- **Mentor**: Prof. Datta Gaitonde

1. Investigated active blowing control in a supersonic multistream single-expansion ramp nozzle (SERN).
2. Analyzed the critical flow dynamics, with emphasis on vortex-shedding instability from the splitter plate and shock–boundary layer interaction (SBLI), using data from Large Eddy Simulation (LES).
3. Applied physics-based methods such as Momentum Potential Theory (MPT) and data-driven methods including Proper Orthogonal Decomposition (POD) and Spectral POD (SPOD) to identify the mechanisms responsible for the observed high and low frequency tones.
4. Demonstrated that active blowing control can effectively suppress the instability mechanisms responsible for these pervasive acoustic tones.

Institute Postdoctoral Fellow & Project Associate July, 2022 - Dec. 2022
Dept. of Aerospace Engineering, Indian Institute of Technology Bombay, Mumbai, India

- **Project**: *Analysis of Shock Breaking Phenomenon at High Turbulent Intensity in Shock–Turbulence Interaction using Lagrangian Coherent Structures.*
- **Mentor**: Prof. Vineeth Nair, Prof. Krishnendu Sinha

1. Explored the phenomenon of shock breaking/shock hole formation within the context of shock-vorticity/ turbulence interaction.
2. Utilized Lagrangian Coherent Structures and data-driven methods (POD) to analyze this phenomenon.

Doctoral Research (Ph.D.) July, 2016 - Nov. 2022
Dept. of Aerospace Engineering, Indian Institute of Technology Bombay, Mumbai, India

- **Thesis**: *Weakly Nonlinear Theory for Shock–Vorticity Interaction.*
- **Advisor**: Prof. Vineeth Nair, Prof. Krishnendu Sinha

1. Developed a theoretical framework to investigate the nonlinear effects in shock–vorticity wave interaction. It is known as a Weakly Nonlinear Framework (WNLF).
2. Identified the significant physical mechanisms that govern nonlinear effects and intermodal interactions, leading to vorticity amplification and pressure generation across the shock.
3. Addressed a long-standing question regarding the range of applicability for LIA and presented a second-order accurate solution using Weakly Nonlinear Framework (WNLF).
4. Developed a mathematical model based on WNLF to investigate nonlinear effects in shock-turbulence interaction.

➤ **Additional Research Activities**

(a) Studied the interaction between acoustic waves and a premixed flame using LIA.
(b) Studied the interaction between an entropy spot, a vortex, and a normal shock utilizing LIA.

M. Tech. Project Jan., 2015 - June, 2016
Dept. of Aerospace Engineering, Indian Institute of Technology Bombay, Mumbai, India

- **Project**: *Simulation of Combustion Instability in Solid Rocket Motor due to Vortex Shedding and Erosive Burning.*
- **Advisor**: Prof. Sudarshan Kumar

1. Performed Large Eddy Simulation (LES) of combustion instability in a solid rocket motor due to vortex shedding and erosive burning using a commercial CFD package.
2. Examined the impact of inhibitor height and varying erosive burning rates, simulated with moving boundary conditions, on pressure fluctuations and spectral characteristics.

PUBLICATIONS (JOURNALS)

1. **Thakare, P.**, Nair, V. & Sinha, K., "A Weakly Nonlinear Framework for Shock–Vorticity interaction," **Journal of Fluid Mechanics, 933**, A48, 2022.
2. **Thakare, P.**, Sinha, K.and Nair, V., "Nonlinear Effects of Shock–Shear Interaction on Pressure: Mean Pressure Drop and Sound Generation," **Physics of Fluids**, 35(1), 2023.
3. **Thakare, P.**, Nair, V. & Sinha, K., "Nonlinear Scaling of Fluctuation Kinetic Energy for Shock–Vorticity Wave Interaction," **Physics of Fluids**, 36(5), 2024.
4. Vighnesh, J. R., **Thakare, P.**, & Nair, V., ***manuscript under preparation***.
5. Prasad, S., **Thakare, P.**, Mahadevan, S., & Duvvuri, S., ***manuscript draft under preparation***.
6. **Thakare, P.**, Prasad, S., Mahadevan, S., & Duvvuri, S., ***manuscript draft under preparation***.
7. **Thakare, P.**, Das, S., Mahadevan, S., & Duvvuri, S., ***manuscript draft under preparation***.

PUBLICATIONS (CONFERENCES)

1. Prasad, S., **Thakare, P.**, Mahadevan, S., & Duvvuri, S., "Effects of Trip Geometry and Leading-Edge Bluntness on High-Speed Boundary-Layer Transition," **Abstract accepted at 25th Australasian Fluid Mechanics Conference**.
2. **Thakare, P.**, Sinha, K., & Nair, V., "Nonlinear Scaling of Fluctuating Kinetic Energy for Shock-Vorticity Wave Interaction," **International shock interaction symposium**, IIT Madras, October 17-19, 2022.
3. **Thakare, P.**, Sinha, K., & Nair, V., "A weakly Nonlinear Analysis for Pressure Generation in Shock–Vorticity Interaction," in **AIAA Aviation 2022 Forum** (p. 4051), June 27- July 1, 2022.
4. **Thakare, P.**, Sinha, K., Nair, V., "Second-Order Analysis of Normal Shock–Vorticity Wave Interaction," 6^{th} **National Symposium on Shock Waves**, IIT Madras, February 26 - 28, 2020.
5. **Thakare, P.**, Sethuraman, Y. P., Sinha, K., Nair, V., "Comparative Study of Linear Interaction Analysis and DNS for Shock–Vorticity Interaction: Scaling of Nonlinear Terms," **Proceedings of the 32nd International Symposium on Shock Waves**, NUS, Singapore, July 14 - 19, Author Index-0293, 2019.
6. **Thakare, P.**, Nair, V., Kumar, S., "Simulation of Combustion Instability in Solid Rocket Motor," **High Energy Materials Conference & Exhibits (HEMCE)**, HEMRL, Pune, Paper no. 5.26, serial no. 311, 23-25 November 2017.
7. **Thakare, P.**, Das, S., Mahadevan, S., & Duvvuri, S., ***manuscript draft under preparation for conference***.
8. **Thakare, P.**, & Duvvuri, S., ***manuscript draft under preparation for conference***.

HONORS/AWARDS

- **Awarded the ANRF–NPDF postdoctoral fellowship** for a two-year tenure starting from November 2025.
- **Seal of Excellence for a high-quality project proposal** in a highly competitive evaluation process by the European Commission Horizon Europe for MSCA (Marie S. Curie Actions) postdoctoral fellowship.
- **Best paper award** at 6^{th} National Symposium on Shock Waves, IIT Madras, 2020.
- **Student competition award** for outstanding achievement in paper presentation at 32^{nd} International Shock Wave Symposium (ISSW), NUS, Singapore, 2019.
- 2^{nd} rank in the batch of 23 students in coursework for aerospace propulsion specialization in M.Tech at IIT Bombay.
- 99.04 percentile in Graduate Aptitude Test in Engineering (GATE - Mechanical Engineering) 2014.
- First prize for project presentation at the national level project competition held at Y.C.C.E., Nagpur, 2014.

INTER GROUP MEETINGS & WORKSHOP PARTICIPATION

- Attended workshop conducted by Manuscriptpedia for Professional Development Program on "Machine Learning in Research: From Modelling to Publication" in March, 2026.
- Attended workshop conducted by NPTEL on the topic "Machine Learning for Fluid Mechanics", 2024.
- Presented research findings on "Weakly Nonlinear Interaction Analysis for Shock-Vorticity Wave Interaction" at Inter-Group Meeting 2020 held at IIT Bombay (Inter-Group Meeting is an unofficial formal gathering of the researchers in the fluid dynamics area from IIT Bombay, IIT Madras, IIT Hyderabad, IISC Bangalore and ICTS Bangalore).

- Presented research on "Quantification of Error in Linear Interaction Analysis for a Normal Shock Vorticity Interaction" at the Inter-Group Meeting 2019 held at International Center for Theoretical Sciences, Bangalore (ICTS).
- Delivered a presentation on the "Interaction of an Entropy Spot with a Shock Wave" at the Inter-Group Meeting 2018 held at IIT Madras.
- Attended JFM Symposium, organized by Cambridge University Press at IIT Bombay from 11-12 December 2017.

COURSEWORK (CREDIT/AUDIT)

Fluid Mechanics and Aerodynamics: Aerodynamics of aerospace vehicles, Hypersonic Flow Theory; Gas Dynamics; Experimental Methods in Fluid Mechanics; Aviation Fuels and Combustion.
Computational and Numerical Methods: Computational Methods for High-Speed Flows; Advanced Numerical Methods for Compressible Flows; Numerical Methods for Conservation Laws.
Data-Driven Methods: Applied Machine Learning (MIT: Data to Decisions; Coursera).

TEACHING ASSISTANCESHIP

1. AE 611 Experimental Aerodynamics Laboratory (PG) (Autumn 2017, 2018, 2019, 2021)
2. AE 312 Experimental Aerodynamics Laboratory (UG) (Spring 2018, 2019, 2020, 2021)
3. AE 780 Computational Heat Transfer and Fluid Flow (Autumn 2020)
4. AE 682 Introduction to Thermoacoustics (Spring 2017)
5. AE 329 Aerospace Propulsion (Autumn 2014)
6. AE 647 Introduction to Plasma for Engineering (Spring 2015)

SKILLS

Programming languages	MATLAB, Python, Fortran, C
Engineering Software	ANSYS Fluent, FieldView, Mathematica, Tecplot, Gambit, Catia, ProE, Autocad, SolidWorks, OpenFOAM
Experimental Techniques	Schlieren imaging, Infrared thermography, Time-resolved measurement
Operating systems	Linux, Windows
Typesetting language	LaTeX, Overleaf
Languages	English, Hindi, Marathi