

Preface: The 4th International Conference on Sustainable Technologies and Advances in Automation, Aerospace, and Robotics (STAAAR 2025)

The 4th International Conference on Sustainable Technologies and Advances in Automation, Aerospace, and Robotics (**STAAAR 2025**) was successfully organized by the School of Mechanical Engineering (SMEC), **VIT Bhopal University, Madhya Pradesh, India**, during **December 17–18, 2025**. The conference served as a premier interdisciplinary platform to explore cutting-edge innovations, emerging trends, and critical challenges in the domains of sustainable technologies, automation, aerospace, and robotics.

Building on the success of previous editions, **STAAAR 2025** was held in collaboration with **IIT Bombay, India**, and **Boston College, USA**, reflecting the growing global emphasis on sustainable engineering and advanced technological integration. The event received generous financial support from the **Anusandhan National Research Foundation (ANRF), Department of Science and Technology (DST), Government of India** — marking the third consecutive year of this prestigious funding for the STAAAR series.

The conference attracted **135 research submissions** from reputed institutions across India, including IITs, NITs, and leading government and private universities, as well as international contributions from Australia, Uzbekistan, and Kyrgyzstan. After a rigorous peer-review process, **58 high-quality papers** were accepted for presentation, achieving an acceptance rate of approximately 43%. The technical program featured **seven keynote talks** by distinguished experts on topics such as Digital Twin for Complex Systems for Sustainability, Beyond Technology Imperialism: Achieving True Sustainability, Human-in-the-Loop Rehabilitation Robotics, Lightweight Materials and Processes for Engineering and Strategic Applications, Learning to Adapt: Design Education and Future-readiness, AI/ML in fluid mechanics and Design Thinking. **Six parallel technical sessions** each day facilitated in-depth discussions on aerodynamics, applied mechanics, biomaterials and biomechanics, sustainable manufacturing, material characterization, AI/ML in fluid dynamics and heat transfer, computational fluid dynamics, and additive manufacturing.

Selected peer-reviewed papers from STAAAR 2025 are being published in the Scopus-indexed proceedings of **EPJ Web of Conferences** by **EDP Sciences**, France, ensuring wide visibility and academic impact.

We express our deepest gratitude to the keynote speakers, session chairs, reviewers, authors, participants, student volunteers, and organizing committee for their invaluable contributions. Special thanks are extended to ANRF-DST, Government of India, for their consistent financial support, and to EDP Sciences

for publishing the proceedings. We also sincerely thank the VIT Bhopal management, faculty, and staff for their unwavering encouragement and logistical support.

We hope this volume serves as a valuable resource for researchers, engineers, and students working toward sustainable and innovative advancements in mechanical engineering and allied fields. Feedback and suggestions from readers are warmly welcomed.

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Dr. Rohit Sharma
rohit.sharma@vitbhopal.ac.in

Dr. Pushpdant Jain
pushpdant.jain@vitbhopal.ac.in

Dr. Praveen Kumar
kumarpf@bc.edu

Prof. Jayendran Venkateswaran
jayendran@iitb.ac.in

About the editors

Dr. Rohit Sharma is currently serving as Senior Assistant Professor and Programme Chair-Mechanical at VIT Bhopal University, India. He earned his Ph.D. from Politecnico di Milano (POLIMI), Italy in Energy and Nuclear Science & Technology in 2017. His research focused on the near-field region of turbulent swirling jets in the combustion & propulsion laboratory. Notably, Dr. Sharma received an esteemed Erasmus Mundus fellowship sponsored by the European Commission in 2013 to pursue his Ph.D. Prior to his doctorate, Dr. Sharma received his M.Tech in Thermal Engineering from NIT Warangal in 2013 and a B.E. in Mechanical Engineering from LNCT Bhopal in 2010. He has ~13 years of vast experience in industry, research and academic institutions. He served as a Senior Project Research Scientist at IIT Bombay, gained valuable teaching experience as an Assistant Professor at NIT Jalandhar, and acquired industrial exposure as a Graduate Engineer Trainee at Vardhman Yarns for one year. Dr. Sharma has an impressive record of 26 publications in esteemed journals and conferences and has been honored with best research paper and poster awards. As a core team member, he actively participated in the student solar ambassador workshop organized under the SoULS project at IIT Bombay, which achieved the Guinness World Record on 2nd October 2018 for lighting the most LED lights based on solar energy. He has contributed to other sponsored projects such as the Energy and Economic Growth (EEG) project in collaboration with the University of California, Berkeley, USA, and Lawrence Berkeley National Laboratory, Berkeley, USA. Also, he worked on the TATA Research project in collaboration with Boston College, USA, under the SoULS, IIT Bombay umbrella. He has recently received an International Travel Grant (2022) in the Young Scientist category, a Seminar/Symposia Grant (2023 & 2025) from ANRF (then SERB), DST, Government of India, and a Support for Excellence in Academic Research (SPEAR 2025) Grant from VIT Bhopal, where he serves as Principal Investigator. He has traveled to numerous countries, including France, Greece, Italy, Poland, Portugal, Saudi Arabia, Switzerland, and the United Kingdom, to present his research at various international conferences. He has been selected as a Senior Individual Member of the Indian National Academy of Engineering (INAE) in October 2025. Dr. Sharma has successfully organised several international conferences and workshops as Organising Secretary and Convener. His diverse research interests encompass Experimental Fluid Dynamics, Optical Diagnostics, Flow Visualization, Internal Combustion Engines, Proper Orthogonal Decomposition, Predictive Modelling, and Sustainable Energy for Rural Development.

Dr. Pushpdant Jain has more than 13+ years of experience including, in industries and academic institutions. Currently, he is working with VIT Bhopal University as a Senior Assistant Professor in the School of Mechanical Engineering. Dr Jain holds PhD in Industrial Design from the National Institute of Technology, Rourkela (Odisha). He has published More than 35+ publications which includes SCI, SCOPUS journal articles, book chapters and conference publications. He has authored 02 books as an Editor. Dr Jain has published more than 20 patents/design registrations and granted with 19 design registrations. He has organized four international conferences, serving as Organizing Secretary for two and as Co-Convenor for two. He is an active member of the European Society of Bio-Mechanics (ESB), Society of Automotive Engineers (SAE), a life member of the International Association of Engineers (IAENG), Indian Institution of Industrial Engineering (SMIIE) and Indian Society for Technical Education. In addition to this, he was awarded with Research Scholar of the Year in the year 2018 at NIT Rourkela for

his PhD Work. His research interests include New Product Development, Spinal Implants, Bio-Mechanics, and Finite Element Analysis. Dr. Jain has international experience as a lecturer for the Asia Summer Programme, organized at Petra Christian University, Indonesia from July 13 to August 02, 2025.

Dr. Praveen Kumar is an Associate Professor at the Boston College School of Social Work and also holds a faculty affiliate status at the Environmental Studies Program, the Global Public Health and the Common Good Program, and the Schiller Institute for Integrated Science and Society, at Boston College. His research focuses on the human dimensions of climate and environment, particularly in South Asia and Sub-Saharan Africa. The overall objective of his research is to examine interventions that address the health and well-being of populations vulnerable to climate and environmental risks. He harnesses field-based studies, systematic reviews, secondary datasets, and system science approaches, particularly social network analysis, to advance his research. Dr. Kumar's work has been supported by the US National Institutes of Health (NIH), the International Growth Centre (UK), the UN Foundation, the World Bank, and the Government of India, among others. He was the NIH Climate Change and Health Scholar for the year 2023, wherein he contributed to strengthening the agency's strategic initiative on climate change and public health by sharing knowledge and helping build capacity for conducting climate change and health research. Early this year, the US National Academy of Sciences selected him as one of the 87 Kavli Fellows – a national recognition to the emerging scholars who are America's brightest young scientists from industry, academia, and the government. Dr. Kumar is an associate editor of the *Annals of Global Health* and is on the editorial board of *PLOS One* and *Nature Humanities and Social Sciences Communications*. Dr. Kumar received his undergraduate degree in engineering from the Institute of Chemical Technology (formerly UDCT), Mumbai. He received his master's in social sciences from the Tata Institute of Social Science, Mumbai, and a PhD in Social Sciences from the Washington University in St. Louis in the US, where he was a McDonnell International Scholar.

Prof. Jayendran Venkateswaran is Professor of Industrial Engineering and Operations Research at IIT Bombay, where he has been a faculty since 2005. His current research and teaching interests are in systems thinking, digital twinning of complex systems, simulation, automation, supply chain, sustainability and OR for development. He loves tinkering with Arduino, Python and other open source tools. He has several publications in leading journals and conferences to his credit. He has guided 10 doctoral students and 40+ graduate (Masters') students. He co-led the Solar Urja through Localisation for Sustainability (SoULS) initiative at IIT Bombay (www.soulsiitb.in) which involves a range of activities towards decentralised renewable (solar) energy access, including skilling, technology development, technology diffusion, adoption & sustainability, rural entrepreneurship & small industries development, etc. Through SoULS, he is also working with several development agencies (State/NGOs/ etc), and rural communities. The initiative has received several awards including the IEEE Empower a Billion Lives Global Award in 2019. Dr. Jayendran completed his Doctorate in Systems & Industrial Engineering, and Masters in Systems Engineering, both from the University of Arizona, Tucson in 2005 and 2002 respectively. He obtained his bachelor's degree, MSc (Tech) in Engineering Technology from the premier undergraduate institute in India, Birla Institute of Technology and Science (BITS), Pilani, in 2000.