

SCIENTIFIC MACHINE LEARNING IN COMPUTATIONAL FLUID DYNAMICS

March 14th, 2027 (from 9 AM to 1 PM)

at ASTFE TFEC2027 Conference in person at Southern Methodist University, Dallas, TX, USA

and partially online virtual via Zoom and Whova

www.astfe.org/courses/mcfd2027/

Dr. Akshai Runchal

Dr. Madhukar M. Rao

Computational Fluid Dynamics (CFD) has long been a major tool of engineering design and analysis, helping engineers model and understand complex flow physics across many applications. High-fidelity simulation still comes at a high computational cost, especially for many-query problems like design optimization, digital twins, and multiscale physics. Scientific Machine Learning (SciML) can act as a helpful aid alongside conventional CFD by combining physics-based modeling with data-driven methods to lower cost, generalize across geometries, and support learned components alongside conventional solvers. This course introduces CFD practitioners a range of topics from foundational SciML concepts to state-of-the-art techniques, including embedding machine learning in CFD/FEM solvers, physics-informed neural networks, operator networks, differentiable solvers, and generative AI and agent-driven CFD.

KEY BENEFITS TO PARTICIPANTS

1. Landscape of Scientific machine learning (SciML): what exists, and which approach fits which class of problem from operator networks and embedded solvers to differentiable solvers
2. See case studies (coolant filling, groundwater flow) showing what these methods actually achieve and where they fall short
3. Understand emerging directions including generative models, differentiable solvers and AI agents for CFD workflows
4. Understand on how to frame decision framework for identifying where ML can meaningfully accelerate your own CFD work

WHO SHOULD ATTEND

- CFD practitioners, engineers, and computational physicists looking to evaluate or adopt ML-augmented simulation methods
- Simulation and design engineers working with computationally expensive or geometry-heavy CFD workflows
- Graduate students and research scholars working at the intersection of CFD and machine learning

REGISTRATION

- Fee: \$100
- Registration will be limited to 50 participants
- A certificate will be given upon completion of the course



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WORKSHOP INSTRUCTORS



Dr. Akshai Runchal

With over 50 years of pioneering experience in Computational Fluid Dynamics (CFD) and numerical simulation, Akshai Runchal is a distinguished expert in flow, heat, and mass transport processes for engineering and environmental sciences. He completed his Ph.D. in 1969 at Imperial College London under the mentorship of Prof. D. B. Spalding. He was a key member of the three-person team led by Prof. Spalding that developed the Finite Volume Method (FVM) for Fluid Dynamics (CFD) starting in 1966, a cornerstone of modern CFD.

In 1979, Akshai established the Analytic & Computational Research Inc. (ACRi) group of companies, which now operates from Los Angeles (USA), Nice (France), and McLeod Gunj (India). In 2011, he founded the non-profit CFD Virtual Reality Institute (www.CFDVRi.org) to advance CFD education, training, and research.

His expertise spans industrial design, production, environmental impact assessments, and disaster management, including Tsunamis, industrial fires, explosions, and hazardous material releases. Akshai has authored or co-authored 10 books and over 200 technical publications and regularly serves as a reviewer for technical journals. He has delivered keynote and invited talks at more than 100 international conferences and seminars.

Dr. Runchal is a fellow of both ASME and ASTFE (American Society of Thermal and Fluid Engineers) and a founding member of ASTFE. He has also served as Chairman of the IIT Kanpur Foundation Board and as a member of the IIT Gandhinagar Advisory Board.

For more details, please use the link below to visit Dr. Runchal's Wikipedia page. https://en.wikipedia.org/wiki/Akshai_Runchal



Dr. Madhukar M. Rao

Dr. M.M. Rao is a distinguished expert in Computational Fluid Dynamics (CFD) with over three decades of experience in research, software development, and consulting. He holds a B.Tech in Aerospace Engineering from IIT Madras (1988) and a Ph.D. from the University of Florida, Gainesville.

Dr. Rao began his career as a Project Engineer at ACRi's Cincinnati office in 1996 and currently serves as the Technical Director of ACRi India. He has played a leading role in the development and implementation of unstructured mesh algorithms in the commercial finite volume CFD software [ANSWER®](#) as well as the implementation of advanced turbulence models including Reynolds Stress Models (RSM), non-linear $k-\epsilon$ models, RNG, and $k-\omega$ variants.

At ACRi, Dr. Rao leads R&D efforts involving CFD solver development (commercial codes: ANSWER, PORFLOW, TIDAL), adaptive mesh refinement, simulation of complex reacting flows, environmental flow modeling, and sub-surface transport. His work extends to the numerical modeling of aerosol transport and dynamics, including applications in air quality.

He is also closely associated with the CFD Virtual Reality Institute (CFDVRi), where he guides education, training, and research activities. Dr. Rao is actively involved in extending CFD through Machine Learning techniques, with a particular focus on Physics-Informed Neural Networks (PINNs) to enhance predictive capabilities and computational efficiency.

Dr. Rao has co-authored the book Computational Fluid Dynamics with Moving Boundaries and has published extensively in reputed journals and conferences.

WORKSHOP OUTLINE

Lecture 1: Machine Learning for CFD: Motivation & Applications

Lecture 2: Scientific Machine Learning & Neural Operators

Lecture 3: Machine Learning Accelerated CFD & Surrogate Models

Lecture 4: Agent-Driven CFD & Differentiable Solvers



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