MESHLESS METHODS FOR FLUID FLOW SIMULATIONS IN COMPLEX DOMAINS

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University of Maryland, MD, USA

www.astfe.org/courses/mmffscd2023/

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Many industrial flows require solutions of the Navier-Stokes equations in complex domains. Currently, unstructured grid finite volume and the finite element methods are commonly used to simulate such flows. These methods require a grid to be first generated on which the equations are discretized. Grid properties such as control volume aspect ratio and edge skewness play an important role in discretization accuracy. Meshless methods are based on discretizing derivatives at scattered points without connecting them with edges, faces and volumes. The advantages of meshless methods include high accuracy, adaptive local refinement, and simpler code.

This short course will describe the basics of interpolation, discretization of the flow and heat transfer equations, and their efficient solution at scattered points. The short course will describe algorithms for heat conduction, incompressible flows, and multi-material domains. A Fourier spectral method to conduct LES/DNS in periodic geometries, and a multilevel technique will be described. Code snippets for interpolation, discretization, and solving the nonlinear coupled equations will be provided.

WHO SHOULD ATTEND

This short course will be of interest to all CFD researchers interested in learning theory and applications of meshless methods for multidimensional, multiphysics simulations. The course will discuss both heat transfer and incompressible fluid flow simulations. Practicing engineers and graduate students pursuing mathematical modeling for multidisciplinary simulations will benefit from this new approach.

REGISTRATION

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

WORKSHOP INSTRUCTOR

PRATAP VANKA

Department of Mechanical Science and Engineering, UIUC

Pratap Vanka is Professor Emeritus in the Department of Mechanical Science and Engineering, UIUC. He has pioneered several numerical algorithms including multigrid methods, Lattice Boltzmann methods, meshless techniques, GPU computing, and partially-parabolic methods. He has taught a graduate level CFD course at University of Illinois for 30 years. He is passionate about developing codes for CFD and heat transfer and has developed more than 25 research level CFD codes since his graduate research at Imperial College. He worked for his Ph. D. with Professor D. B. Spalding (late), a pioneer in computational fluid dynamics and computational heat transfer. Pratap Vanka has published more than 170 papers in journals and reviewed technical conferences on heat transfer, metal solidification, combustion and computational methods. He has received several teaching and research awards. He is a Life Fellow of ASME, Fellow of APS, Associate Fellow of AIAA, and recipient of the ASME Freeman Scholar lecture award.

WORKSHOP OUTLINE

Module 1: Interpolation of scattered data, global and cloud-based methods. Accuracy and stability

Module 2: Solution of heat conduction equation, multidomain methods

Module 3: Explicit and Semi-implicit fractional step methods for fluid flows

Module 4: Multilevel meshless method