3-DAY COURSE

INTRODUCTION TO COMPUTATIONAL TECHNIQUES FOR MULTIPHASE FLOWS

July 17-July 19, 2017
I-Hotel,
Champaign, IL

An introductory 3-Day course covering gas-particle and gas-liquid flows

ASTFE
American Society of Thermal and Fluids Engineers

SCOPE

Multiphase flows are encountered in a wide variety of industries including nuclear, aerospace, chemical, mechanical and biological engineering. Multiphase flows may involve gas-solid mixtures, gas-liquid mixtures and liquid-liquid mixtures. Based on the nature of the flow, a variety of computational techniques have been developed. These include Eulerian-Lagrangian methods for dilute dispersed flows including two-way coupling, Eulerian-Eulerian techniques with interface capturing and Eulerian-Eulerian methods for volume-averaged equations. The techniques for interface capturing include Volume of Fluid (VOF), Level-Sets (LS), and Front Tracking (FT).

This course will introduce the various techniques for multiphase flows by experts who have directly developed and implemented such techniques. Our intent is to give as many details as possible, and describe their implementation in a model Navier-Stokes solver for two-dimensional flows. The course is divided into three days, beginning with the governing equations and volume averaging of the phasic equations of a mixture. The modeling of the interphase coupling terms is discussed with their assessment in some complex flows. Day 2 will cover the computation of dilute gas particle flows and introduce front tracking algorithm for gas liquid flows. Day 3 will be devoted to other interface tracking algorithms including VOF, LS and coupled VOF and LS algorithms, followed by brief introduction to Eulerian-Eulerian techniques.

OBJECTIVES

THE OBJECTIVES OF THE COURSE ARE:

1. Introduce the basic equations of two-phase flow formulations

2. Discuss solution methods for dilute gas particle flows

3. Discuss techniques for gas liquid flows with interface capturing using VOF, level-sets, and front tracking methods

4. Discuss Eulerian-Eulerian techniques for gas-liquid and gas-particle flows using volume-averaged techniques

5. Provide examples of multiphase flow computations from lecturer's research groups

WHO SHOULD ATTEND

This course is intended for those who wish to understand the basic numerical methods for multiphase flows. The course is suitable for both postgraduate students and engineers and scientists in industry and government. Students with an engineering or mathematical background should have no difficulty in grasping the underlying principles of the methods and their applications to various fields.

COURSE INSTRUCTORS

PRATAP VANKA

University of Illinois at Urbana-Champaign

Pratap Vanka is Professor Emeritus and Research Professor in the Department of Mechanical Science and Engineering. 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 25 years, and continues to teach that course after taking Emeritus status. 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 close to 170 papers in journals and reviewed technical conferences. He has received both teaching and research awards. He is a Life Fellow of ASME, and Associate Fellow of AIAA, and recipient of the ASME Freeman Scholar lecture award.

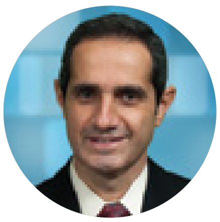
GRETAR TRYGGVASON

University of Notre Dame

Gretar Tryggvason is the Viola D. Hank professor at the University of Notre Dame and the chair of the Department of Aerospace and Mechanical Engineering. He received his PhD from Brown University in 1985 and was on the faculty of the University of Michigan in Ann Arbor until 2000, when he moved to Worcester Polytechnic Institute as the head of the Department of Mechanical Engineering. He moved to the University of Notre Dame in 2010.

COURSE INSTRUCTORS

Professor Tryggvason is well known for his contributions to computational fluid dynamics; particularly the development of methods for computations of multiphase flows and for pioneering direct numerical simulations of such flows. He served as the editor-in-chief of the Journal of Computational Physics 2002-2015, is a fellow of APS, ASME and AAAS, and the recipient of several awards, including the 2012 ASME Fluids Engineering Award.



FARZAD MASHAYEK

University of Illinois at Chicago

Farzad Mashayek is currently a Professor and Head of the Department of Mechanical and Industrial Engineering at the University of Illinois at Chicago. Mashayek has conducted research on Eulerian-Lagrangian particle/droplet-laden turbulent flow modeling and simulation for more than two decades. His early work was focused on homogeneous turbulent flows. After conducting the first DNS of evaporating droplets in an incompressible isotropic flow, Mashayek was the first to simulate particle dispersion in compressible flows, and later extended the work to consider droplet evaporation in homogeneous isotropic and shear flows. Further extension of this work included chemical reaction and produced detail information of various mechanisms of droplet-turbulence interactions. His research group has also developed advanced stochastic models for RANS simulation of particle dispersion in turbulent flows. More recent work of Mashayek was directed towards development and implementation of advanced spectral element codes for non-homogeneous turbulent flow configurations. Mashayek spent the summers of 2007 and 2008 as a Summer Faculty Fellow at the National Center for Supercomputing Applications (NCSA) working on implementation and optimization of these spectral element codes on massively parallel supercomputers.

CALEB BROOKS

University of Illinois at Urbana-Champaign

Caleb Brooks is an assistant professor at the University of Illinois at Urbana-Champaign in the department of Nuclear, Plasma, and Radiological Engineering. His research interests include nuclear reactor thermal-hydraulics, validation of safety analysis codes and computational fluid dynamics codes, as well as, research and design of next generation reactor systems. Dr. Brooks received his Ph.D. from Purdue University where he worked in the Thermal-hydraulic and Reactor Safety Laboratory (TRSL). In 2013 he was the recipient of both the Purdue University 'College of Engineering Outstanding Research Award' and 'College of Engineering Outstanding Service Award'.

COURSE OUTLINE

1 Day 1: Governing Equations and Numerical Methods

Overview of Course (Vanka, 30 mins)

Multiphase Flows in Engineering (Brooks, 30 mins)

Time averaging of local-instant formulation (Brooks, 3 hrs)

Determinism of the two-fluid model

Interfacial transfer modeling

Interfacial area concentration modeling

Review of existing data and validation efforts

Basic Numerical Methods (Vanka, 1 hr)

- Finite Difference Method
- Finite Volume Method

Fractional step algorithm for Incompressible Flows (1 hr)

2 Day 2: Gas Particle and Gas-Liquid Flows

Lagrangian Particle Tracking algorithm (Mashayek, 4 hrs)

Forces on a particle

Two-way coupling methods

Implementation

Applications

Gas-liquid flows with Front tracking (Tryggvason 2 hrs)

Methodology

Dinner Reception: Day 2, 6-9 pm

3 Day 3: Gas-liquid flows

Gas-liquid flows with Front tracking (Tryggvason 2 hrs)

Implementation

Applications

Interface Tracking Methods (Vanka, 3 hrs)

Level Sets

Coupled Level Sets and VOF

Implementations and Applications

Eulerian-Eulerian Numerical Techniques (1 hr)

REGISTRATION

FEE: $300

The fee for the course covers instructional material costs, break refreshments, and lunch each day. All fees must be paid in advance at least two weeks before the start of the course. Pay by credit card, check, money order, or request to bill employer.

Please use the form that can be found online at: www.astfe.org/courses/ctmf/

Cancellations must be received at least two weeks before the course begins; substitutions will be accepted. In the event that insufficient registrations or any situation beyond our control warrants cancellation of the course, participants will be notified immediately and a full refund will be issued.

Registration will be limited to 30 attendees.