Numerical Modeling of Multiphase Flows

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Overview

In engineering and environmental fluid flows, the presence of multiple interacting phases is ubiquitous. One phase can be dispersed into another (e.g., solid grains in gas or liquid), or both phases can be continuous, separated by a phase interface (e.g., liquid-gas flow). In both cases, the resulting flow is often turbulent, spans many characteristics length and time scales, and exhibits complex non-linear dynamics such as particle clustering, interfacial instabilities, and droplet break-up and coalescence. This short course will cover modern numerical methods for the computational modeling of multiphase flows, which represent a major hurdle in process innovation and intensification. This course will enable engineers and research specialists with knowledge of fluid mechanics and scientific computing to develop a comprehensive understanding of numerical modeling of multiphase flows, especially in the field of multiphase turbulence. It will present basic techniques and recent progress in multiphase flow simulations, while establishing important connections with the underlying fluid dynamics basics. The course will cover both Eulerian and Lagrangian particle-laden flow modeling techniques, and techniques for two-phase flows with a deforming interface. Further, it will present and explore multiple examples of multiphase turbulence both in academic configurations and in real engineering systems.

Course information	**Course duration:** Oct 30 – Nov 10, 2017 **Total Contact Hours:** 44 hours lectures and 8 hours tutorials **Number of participants for the course will be limited to fifty.**
Topics to be covered	**1. Introduction to Multiphase Flow Modeling (6 lectures)** Introduction to multiphase flows and their classifications; Governing equations for multiphase flows; Introduction to turbulence; Introduction to Computational Fluid Dynamics **2. Fundamentals of Particle-Laden Flow Simulations (12 lectures)** Lagrangian and Eulerian viewpoints, statistical representation of particles; Micro vs. meso vs. macro-scale models; Particle-resolved direct numerical simulations; Point-particle simulations; Two-fluid model, quadrature-based method of moment; Two-way interphase coupling, drag modeling; Particle collisions and four-way coupling **3. Fundamentals of Liquid-Gas Flow Simulations (12 lectures)** Interface representation and transport; Level Set methods; Conservative Level Set method; Volume-of-Fluid; Lagrangian methods; Curvature calculation; Ghost Fluid method; Mass and momentum conservation; Solution of discontinuous pressure equation; Compressible liquid-gas flows **4. Computational Studies of Multiphase Turbulence (8 lectures)** Preferential concentration; Cluster-Induced Turbulence; RANS modeling for CIT and beyond; Interfaces in turbulence; Turbulent atomization Tutorials: Simulating turbulent atomization **5. Special Topics in Multiphase Flows (6 lectures)** Contact line modeling; Three-phase flows; Evaporation and chemically reacting two-phase flows; Electrohydrodynamics for two-phase flows **Tutorials:** Multiphase problems solving using Level Set method, VOF method, GFM method
You Should Attend If…	• Executives, engineers and researchers from academia, government organizations including R&D laboratories with a background in aerospace, mechanical, and chemical engineering. • Postgraduate students (MSc/MTech/PhD) and faculty from reputed academic and technical institutions.
Fees	The participation fees for taking the course is as follows: **Participants from abroad : US $800** **Industry/ Research Organizations: INR 40000** **Academic Institutions: INR 10000** The above fee include all instructional materials, computer use for tutorials and assignments, laboratory equipment usage charges, 24 hr free internet facility. The participants will be provided with accommodation on payment basis.

The Faculty

Dr. Olivier Desjardins is an associate professor of mechanical and aerospace engineering at the Cornell University. Prior to that, he was on the Mechanical Engineering faculty at the University of Colorado at Boulder. He received a Master of Science in Aeronautics and Astronautics from ENSAE (Supaero) in Toulouse, France, in 2004. The same year, he received a Master of Science in Mechanical Engineering from Stanford University. He obtained a Ph.D. in Mechanical Engineering from Stanford University in 2008. He received an NSF CAREER award in 2014 to work on turbulence modeling around liquid-gas interfaces. He was presented with the Junior Award from the International Conference on Multiphase Flow in 2016. He is also an associate editor and editorial board member for the Atomization and Sprays Journal.

Dr. Desjardins' research focuses on large-scale numerical modeling of turbulent reacting multiphase flows with industrial application. Using world-class parallel computers, his group develops numerical methods and models to investigate the multi-scale and multi-physics fluid mechanics problems that arise in a range of engineering devices, such as combustors or biomass reactors. High-fidelity computational techniques such as large eddy simulations and direct numerical simulations are at the heart of Dr. Desjardins' research. By enabling the exploration of complex non-linear flow physics from first principles, these techniques have the potential to guide the development of highly optimized energy and propulsion systems.

Dr. Santanu De is an assistant professor of Mechanical Engineering at Indian Institute of Technology, Kanpur since 2014. His research interests include CFD of reactive flows using RANS, LES and DNS approaches, modeling of turbulent combustion using flamelet model, conditional moment closure method, multiple mapping conditioning approach and stochastic PDF methods, droplet and spray combustion, coal gasification and combustion

Course Co-ordinator

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