

**Computational Fluids Dynamics and its  
Application to Multiphase Flows (3 credits)**  
计算流体动力学及其在多相流中的应用



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Synopsis	Multiphase flows are ubiquitous in the industry (particles, drops and bubbles in petroleum, nuclear engineering and energy transformations). The numerical simulation has proven to be an efficient tool for engineers and researchers to understand and model the complex interplay between the continuous phase and the dispersion of discrete elements. The purpose of lectures is to introduce numerical simulations of dispersed two-phase flows and advanced topics in computational fluids mechanics, including particle suspensions, bubbly liquids and droplet sprays. Lectures on classical numerical approaches for solving Navier-Stokes equations will be introduced, together with their applications to multiphase flows (dispersion, two-way coupling, modelling of hydrodynamic interactions). Students will be trained to program some classic examples of important phenomena. Students will work on projects using Matlab to simulate particle suspension flows, bubble and droplet dispersion.
Offering	2014 Summer Semester
Audience	Year 3 & 4 Undergraduates and Year 1 Graduate Students
Classroom	Room xxx, Teaching Bldg. No. XX, Peking University
Schedule	<u>Class</u> : 1-4 PM, M-F, July 7 – 26, 2014; <u>Final Exam</u> : 1-4 PM, July 26, 2014

**Objective** To develop an understanding of the physics of two-phase dispersed flows. The students will be trained to the specificity of particles, drops and bubbles dynamics in order to have a better ability to develop numerical modeling. Numerical simulations of complex industrial configurations will be discussed.

- Topics**
1. Introduction to computational fluids mechanics
  2. Examples of two-phase flows in engineering applications
  3. Particle and Bubble dynamics (Forces)
  4. ODE equations for particle trajectories
  5. Suspension flows and hydrodynamic interactions
  6. Numerical techniques for two-way coupling simulations
  7. Numerical project on particles/bubbles in fluid flows

- References**
1. Roland Clift, John R. Grace, Martin E. Weber, *Bubbles, Drops, and Particles*, Dover Books on Engineering (ISBN 0486445801, 9780486445809).
  2. C. Clayton T. Crowe, John D. Schwarzkopf, Martin Sommerfeld, Yutaka Tsuji, *Multiphase Flows with Droplets and Particles*, CRC Press, 2011 (ISBN 1439840504, 9781439840504).
  3. S. Balachandar and John K. Eaton, *Turbulent Dispersed Multiphase Flow*, Annual Review of Fluid Mechanics Vol. 42 (2010): 111-133.
  4. Andrea Prosperetti, Grétar Tryggvason, *Computational Methods for Multiphase Flow*, Cambridge University Press, 2007 (ISBN 0521847648, 9780521847643).
  5. Journal Papers

Grading	Homework	20%
	Numerical Project	30%
	Midterm Exam	25%
	Final Exam	25%
	<b>Total</b>	<b>100%</b>