

# Advanced Computational Fluid Dynamics

## Singapore: 3<sup>rd</sup> to 5<sup>th</sup> April 2018

**An opportunity to ensure that your organization gets maximum benefit using CFD**

**Register now to secure your early bird registration fee**

*“Even experienced CFD users find choosing the right turbulence model a challenge. In his course on Turbulence, Kamran provided exceedingly useful and clear descriptions of the available models in most CFD codes. The course was very helpful in deciding which turbulence model should be used in order to provide the best combination of accuracy and efficiency. I would strongly recommend this course to all CFD users.” Keagan Chee @NING Research*

### **Motivation.**

The NAFEMS Advanced CFD course provides an in-depth practical and structured understanding of the most important technical aspects of CFD simulation which are the basis for robust CFD solutions across a broad range of application areas.

The course is broken into two parts. Part One, covered in the first day, recaps the fundamentals of CFD and serves either as an introduction for those taking up CFD or a refresher to experienced users. This helps to ensure all students have a common level of understanding and are ready for the more advanced concepts. The first day of Part 2 looks at the wide range of turbulence models available and explains how, why and when to use these models. The last day looks at other advanced areas which are becoming much more commonly used such as multiphase flow and fluid structure interaction. We finish the course with a discussion of steps required to perform verification and validation of the CFD solution.

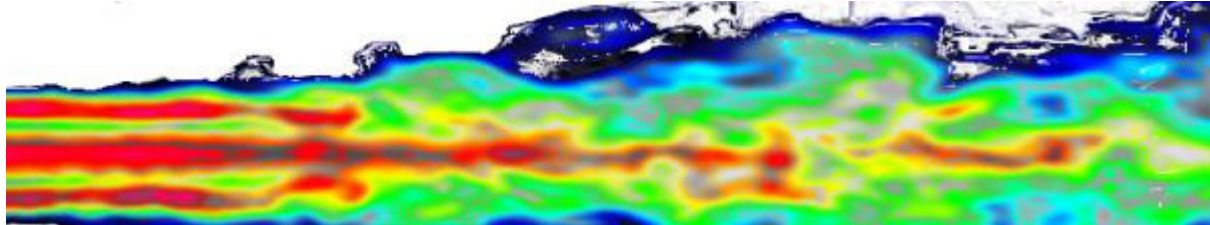


Figure 1. Techniques for simulating turbulence in CFD are a key part of the course

### **Who Should Attend?**

This course is aimed at practicing engineers who wish to learn more about how to apply Computational Fluid Dynamic techniques to their particular problems in the most effective manner. This course is useful for managers who review CFD reports and contract suppliers.

The material presented is independent of any particular software package, making it ideally suited to current and potential users of all commercial finite element software systems. This course is a must for all engineers aiming to use CFD as a reliable predictive tool for the analysis of fluid and gas flow as well as those working on multi-physics problems where CFD is coupled with FEA or other simulation software.

Companies moving into CFD technology to improve product designs or assess prototype failures or speed the design process will benefit from sending key engineers to this course.

**The course is open to both members and non-members of NAFEMS.**

## Course Programme

A full set of printed and bound notes will be issued to every attendee.

### Day 1- Revision on Fundamentals of CFD

- The role of CFD
- Fluid dynamics definitions and governing principles
- Basic Equations of Fluid Mechanics (Continuity, Momentum and Energy Equations)
- Important phenomena & concept in fluid dynamics:
  - *Fluid properties*
  - *Boundary layer*
  - *Pressure loss & recovery*
  - *Flow separation*
  - *Shocks*
- Non-dimensionalization and flow classifications
- CFD basics
  - *Geometry and model simplification*
  - *Meshing and mesh quality*
  - *Initial and boundary conditions*
  - *Analysis- monitoring and convergence*
  - *Post processing*
- Differencing alternatives
  - *Finite difference*
  - *Finite volume*
  - *Finite elements*
- Pressure based vs. density based schemes
- Implicit vs. explicit
- Discussions on errors and uncertainties

### Day 2-Part 2/1: CFD Advanced Topics

- Turbulence Modeling
  - *Understanding turbulence*
  - *Energy cascade and vortex stretching*
  - *Turbulence scales*
  - *Turbulence simulation approaches*
  - *RANS time averaging*
  - *Turbulence modeling*
  - *First order models: One-equation & Two-equations models*
  - *Dealing with walls*
  - *Wallfunction and wall integration*
  - *Setting boundary conditions*
  - *URANS*
  - *Turbulence models comparison*
  - *Choosing a modeling approach*
  - *Large eddy simulation*
  - *Hybrid turbulence models and scale resolving simulation*

### Day 3-Part 2/2: CFD Advanced Topics

- Fluid Structure Interaction
  - *Need for CFD in structural analyses*
  - *Physical and numerical coupling*
  - *Weak to very strong coupling*
  - *1-way, 2-way, and full coupled approaches*
  - *Flow induced vibration problem*
- Heat transfer analysis
  - *Modes of heat transfer*
  - *Forced vs. natural convection*
  - *Prandtl number and thermal boundary layer*
  - *Wall boundary conditions*
  - *Heat transfer coefficient and Nusselt number*
  - *Periodic flows*
  - *Conjugate heat transfer*
- Multiphase flow modeling
  - *Examples, objectives, and challenges*
  - *Multiphase flow classifications*
  - *Variables of interest*
  - *Eulerian methods – VOF, Mixture, and Eulerian-Eulerian Model models*
  - *Cavitation modeling*
  - *Fluid-particle coupling*
  - *Particulate loading – 1-way, 2-way, and 4-way coupling*
- Quality of CFD Simulations
  - *Errors and uncertainties*
  - *Best practice for managing errors and uncertainties*
  - *Validation & verification*
  - *CFD in design and optimization*

Registration will be held on Tuesday morning between 8.30am and 9:00am, with the course starting immediately afterwards. The tutor will aim to commence the course at 9.00am on both days and finish by 5pm each evening. Each day there will be short morning, lunchtime and afternoon breaks.

## Course Tutor



**Kamran Fouladi Ph.D., PE.** is an Assistant Professor of Mechanical Engineering at Widener University teaching undergraduate and graduate thermal fluid courses. He is an educator, researcher, and specialist in Computational Fluid Dynamics (CFD) and thermal management with more than 25 years of engineering and teaching experience. Kamran is a licensed Professional Engineer in Pennsylvania.

Kamran's career began in aerospace arena working at NASA Langley and United Technologies' Pratt and Whitney (P&W) prior to establishing InfoMec CFD Consulting in year 2000. With InfoMec, Kamran has provided engineering and CFD support to projects of national importance (NASA Crew Exploration Vehicle, NASA Orion's Launch Abort Vehicle, NASA Orbital Space plane, and NASA supersonic transport and business jet aircraft) using in-house, public domain, and commercial CFD software.

Kamran's research work is currently aimed at developing and utilizing state-of-the-art airflow, heat transfer, and energy simulation tools focusing on complex configurations and mission critical applications.

## Venue

Holiday Inn Singapore Orchard City Centre  
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Situated in the heart of Orchard Road, Singapore's premier business and shopping district. The Holiday Inn® Singapore Orchard City Centre is only minutes away from the MRT (subway) station, with easy access to entertainment and dining spots and only 25 minutes' drive to and from Changi International Airport.

## Accommodation

We have negotiated a small number of rooms at the Holiday Inn Singapore Orchard City Centre. The NAFEMS Training course accommodation rate is SGD 250++ inclusive of one complimentary daily breakfast. The rate is available up to 1 month before the course, subject to availability.

## About NAFEMS

NAFEMS is the International Association for the Engineering Modelling, Analysis and Simulation Community. We focus on the practical application of numerical engineering simulation techniques such as the Finite Element Method for Structural Analysis, Computational Fluid Dynamics, and Multibody Simulation, website: [www.nafems.org](http://www.nafems.org)

## About C4D Pte. Ltd.

C4D is the ASEAN Region representative for NAFEMS and works to grow NAFEMS membership within the region. C4D has engaged with many leading organisations to help bring the benefits of NAFEMS membership and Professional Simulation Engineer (PSE) certification.



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