Course Overview

The topic of multi-phase and multi-complement flow (MPMC) has wide spectrum of applications. In the process of oil extraction and transportation, oil is mixed with water and gases; in digital lab-on chip, droplet transport in an aqueous solution; boiling and condensation processes; in manufacturing process melting and solidification are few examples to mention on MPMC. Lattice Boltzmann method is very powerful method to handle the mentioned problems. Since, Lattice Boltzmann method (LBM) is based on mesoscale, it is natural to integrate thermodynamics with transport phenomena. While in conventional methods, such as finite volume or finite element, it is difficult to integrate the thermodynamic with transport equations. Also, in LBM there is no need to track the interface explicitly. Besides, the coding of LBM is much easier than that of convectional methods. We think that engineers in academia and in industry should have a knowledge on how to simulate sophisticated and challenging problems involved MPMC. These days single phase flow and transports can easily be handled with many available softwares. However, MPMC problems are challenging and need deep physical understanding and modelling. LBM should be the method of choice for dealing with such complex physics. Unfortunately, most engineering schools do not teach statistical mechanics and thermodynamics which are the prerequisites for understanding LBM.

In this course, we will cover a brief history of Lattice Boltzmann method and the essentials of statistical mechanics sufficient to build a background to understand LBM. The course will be very useful for graduate students and faculty members to perform simulation and carry their research on LBM. Also, the course is useful to engineers in industry for simulation of more complicated processes.

Course Content

Following are the contents of this course in brief:

- Governing equations and fundamentals of Lattice Boltzmann Method
- Single phase fluid flow, heat and mass transfer
- Dealing with force term in Lattice Boltzmann Method; incorporating multi-physics via force term
- Free energy method applied for liquid-gas flow and binary liquid flow
- Shan-Chen pseudo-potential method for multiphase flows
- Boiling and condensation
- Phase change heat transfer
- MRT and Cascade Lattice Boltzmann Method for multiphase flows
- Discussion on advanced topics in Lattice Boltzmann Methods and future direction for research in this area

Objectives

The primary objectives of this course are as follows:

- Know the history of Lattice Boltzmann Method
- Understand the basics of Lattice Boltzmann Method
- Understand phase change mechanisms and simulation of emulsified fluids
- Simulate melting and solidification processes
- Simulate droplet generation and manipulations in micro-channels
- Simulate boiling processes
- Simulate multi-component flows

GIAN
Global Initiative of Academic Networks

Ministry of Human Resource Development, **Government of India**

10 Days* course on

Lattice Boltzmann method *for* Multi-phase and Multi-component flows

(*Lectures: 20 hours and Practical Sessions: 10 hours)

August 5-16, 2019

Course Instructor

Prof. Abdulmajeed A. Mohamad

Department of Mechanical and Manufacturing Engineering
CEERE, Schulich School of Engineering
University of Calgary, Canada

Course Coordinator

Dr. Shanmugam Dhinakaran

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The Centre for Fluid Dynamics
Department of Mechanical Engineering
INDIAN INSTITUTE OF TECHNOLOGY INDORE
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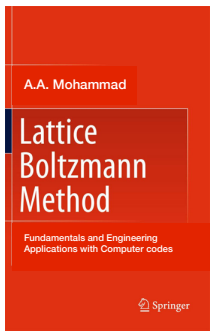
Teaching Faculty

Prof. Abdulmajeed A. Mohamad is a Professor of Mechanical Engineering in the Thermofluids Laboratory at the University of Calgary, Canada. His research interests include Molecular Dynamics and Lattice Boltzmann fluid flow and heat transfer simulations; Adsorption in Fixed Porous Bed; CFD methodology and applications; Double diffusive modelling; Electronic Cooling; Energy system analysis; Flow and Temperature Visualization Technique; Heat transfer in manufacturing process; Mathematical modelling; Modelling tin bath in float glass manufacturing; Mixed Convection in Liquid Metals and Ordinary Liquids; Natural Convection; Radiation; Combustion and Heat and Mass Transfer Porous Media; Radiative Heat Transfer in three-dimensional Furnaces; Solar Energy; Stability Analysis; Turbulent Flow Modelling

Prof. A.A. Mohamad has undertaken several industrial consultancy work in area of thermal science and engineering in USA, Canada and Japan. He is a recipient of several awards for his excellence in teaching and research. He is the author of the widely adopted book on 'Lattice Boltzmann Method: Fundamentals and Engineering Application with Computer Codes' published by Springer. Prof. A.A. Mohamad has over 250 high quality research publications in the aforementioned areas.



The widely adopted book of Prof. Abdulmajeed A. Mohamad on Lattice Boltzmann Method. The 2nd edition of this book will be available in 2019 by Springer

Course Coordinator

Dr. Shanmugam Dhinakaran is an Associate Professor at the Department of Mechanical Engineering, Indian Institute of Technology Indore, India. He received his PhD in the area of Computational Fluid Dynamics and Heat Transfer from IIT Kharagpur, India in 2008. Before joining IIT Indore as an Assistant Professor in 2012, he has worked as a post doctoral researcher at the Université de Pau et des Pays de L'Adour, France; Universidade do Minho, Portugal; Faculdade de Engenharia da Universidade do Porto, Portugal and Université de Valenciennes et du Hainaut-Cambrésis, France.

Dr. Dhinakaran is also an adjunct faculty in the Department of Biosciences and Biomedical Engineering, IIT Indore. He is the coordinator of The Centre for Fluid Dynamics, IIT Indore. Bluff body flows; Non-Newtonian fluid flows; Heat transfer in Porous media; Nanofluids and Biofluid Mechanics are his research interests.

Who should attend?

- Executives, engineers and researchers in the broad area of biomedical, environmental, industries interested in miniaturized system; electronic cooling systems designers and manufacturer, service and government organizations including R&D laboratories.
- Students at all levels (B.Tech/M.Sc/M.Tech/Ph.D) or Faculty from reputed academic institutions and technical institutions. Fundamental of fluid mechanics or equivalent); undergraduate course on general physics and fundamentals of electricity.

Examination & Certificate

An examination will be conducted at the end of the course and grade sheet as well as participation certificate will be give to all the participants.

Travel Information

IIT Indore is located at central part of India in Indore City . For more information, please visit the course website.

Registration Fee

UG & PG Students	Rs. 5,000
Research Scholars	Rs. 10,000
Faculty members	Rs. 15,000
Industry, R&D Organizations	Rs. 30,000

The above fee include all instructional materials; computer use for tutorials and assignments; laboratory equipment usage charges; 24 hr free internet facility. Fee concession may be considered for individual having limited financial support

How to Register?

1. Send an e-mail to the coordinator (sdhina@iiti.ac.in) expressing your interest and wait for acceptance.
2. If accepted, pay the relevant fee online and send the details to the course coordinator.

Important dates and venue

Last date for Registration	August 2, 2019
Course schedule	August 5 - 16, 2019
Venue	IIT Indore, Indore, India

Accommodation

Limited paid accommodation may be provided to participants on first-come-first-serve basis depending on availability. Participants are advised to make their own arrangement if accommodation is not available.

Contact Details

Almost all the information regarding eligibility, fee payment, travel information, accommodation, etc., are available in the course website. If you have any other queries, you may write to or call the course coordinator.

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