Wetting, Capillarity and Phase Transitions: Experiments and Simulations

Overview

Drops, bubbles, and their interactions with surfaces have plenty of occurrences in natural phenomena, starting from raindrops falling on leaves to hydrophobic feet of insects demonstrating mesmerizing natural phenomena. In industrial/technological processes such as printing, coating, atomization, spray cooling, anti-fouling, anti-icing, etc., the dynamics of a droplet is the key factor in controlling process parameters. Understanding the dynamics of such fluid entities with solid surfaces is a fundamental multi-disciplinary research problem having an intricate amalgamation of physics, chemistry, material science, mathematics, and engineering. The real-life applications of these phenomena, at both macroscopic and microscopic scales, require a sound understanding of phase transition mechanisms such as boiling, condensation, and evaporation.

The present course is driven by these requirements and distributed broadly into two sub-parts. The first part will introduce the theoretical fundamentals of wetting and capillarity. Further, it will focus on experimental and simulation techniques required to investigate the dynamics of drops, bubbles, and their interaction with different wettability surfaces. The other part will introduce the fundamental aspects of phase change phenomena and their industrial applications. In this course, we will target to teach the participants both experimental and numerical techniques in interfacial flows and heat transfer, with an overarching goal of providing comprehensive knowledge of how fluidic systems play a role in disparate length scales.

Objectives

The primary objectives of the course are as follows:

i) Demonstration of a thorough theoretical understanding of wetting, capillarity and phase transitions,
ii) Introduction with trends in modeling, design, analysis, CFD/CMFD methods and experimentation,
iii) Presentation of a condensed, critical, and updated view of basic knowledge and future developments, in relation to systems and phenomena encountered in industrial applications,
iv) Competent design problems related to thermal management of microelectronics,
v) Interdisciplinary transfer of knowledge from one area of applications to another related to interfacial flows and heat transfer.

Modules	**A: Fundamentals of wetting and capillarity : April 28 - April 30, 2025 (03 Days)** **B: Experimental and simulation techniques : May 01 - May 02, 2025 (02 Days)** **Number of participants for the course will be limited.**
You Should Attend If…	▪ Executives, engineers, and researchers from industry, and government organizations, including R&D laboratories. ▪ Students at all levels (BTech/MSc/MTech/PhD) or Faculty from academic institutions.
Fees	The participation fees for taking the course are as follows: **Participants from abroad: US $200** **Industry: INR 7,500/-** **Officers of Govt. Organizations/NGOs: INR 5,000/-** **Faculty or Scientists of Research/Academic Institutions: INR 5,000/-** **Students: INR 1,000/-** The above fee includes all instructional materials, computer use for tutorials and assignments, laboratory equipment usage charges, and internet facility. The participants will be provided with accommodation on a payment basis at IIT Mandi hostels and the guesthouse based on availability.

The Faculty

Prashant Valluri is a Professor of Fluid Dynamics and Director of Chemical Engineering at The University of Edinburgh. He received his PhD (2004) in Chemical Engineering from Imperial College London. His research focuses on tackling industrial multiphase flows with phase-change using bespoke numerical and theoretical techniques. These include stability analyses to understand interfacial instabilities, and DNS for combined heat-mass-momentum transport such as flows with phase change, and flows with mass-transfer and interfacial reactions. He also Chairs the UK-wide Multiphase Flows and Transport Phenomena Special Interest Group under the UK Fluids Network. As PI of ARCHER/HECToR eCSE 0804, e174 and e643 projects he led the development of the ultra-fast high-resolution TPLS 3.0 (Two-Phase Level-Set: https://sourceforge.net/projects/tpls/) and the GIS 1.0 (Gerris Immersed Solid Solver: https://github.com/eessmann/GISS), VaPor (Vascular Porous Solver: https://github.com/sblowers/VaPor) and XCompact3D Immersed Solid Solver: https://github.com/xcompact3d/Incompact3d) solvers. These solvers have been employed to gain understanding of fundamental phenomena during oil-gas flows, carbon-capture, brain-cooling, and phase-change cooling of microelectronics. He is currently the DST VAIBHAV Fellow at International Centre for Theoretical Sciences – Tata Institute for Fundamental Research, Bangalore.

Dr. Parmod Kumar is an Assistant Professor in the School of Mechanical and Materials Engineering at IIT Mandi. He has been actively involved in teaching courses related to the thermal-fluids and has been actively involved in research in the similar domain for the past 6 years. His research expertise lies in computational and experimental fluid mechanics, heat transfer, and energy systems, with applications in renewable energy and thermal management. Dr. Parmod has co-authored over 30 peer-reviewed journal articles, with publications in prestigious outlets such as the American Institute of Physics, American Chemical Society, and Elsevier journals. Additionally, he has also written a book on “Basics of Thermodynamics” for AICTE outcome-based education program.

Dr. Sarthak Nag is an Assistant Professor in the School of Mechanical and Materials Engineering at Indian Institute of Technology Mandi. He has been actively teaching courses in the thermal-fluids domain while pursuing research in closely related areas for nearly 3 years now. His primary research interests include experimental nanofluidics, thermal management systems, and water filtration technologies. Dr. Sarthak has co-authored over 10 peer-reviewed journal articles, with publications in prestigious outlets such as the American Society of Mechanical Engineers, American Chemical Society, American Physical Society, Elsevier, and Springer-Nature journals. Additionally, he contributes to book chapters with renowned international publishers.

Course Coordinators

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Registration Link:
https://forms.gle/5EKXqXSapSQiVwMj8

Venue: School of Mechanical and Materials Engineering, Indian Institute of Technology Mandi