



# CHEMICAL ENGINEERING FLUID DYNAMICS AND HEAT TRANSFER

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**PRE-REQUISITES** : Courses in calculus and in mass and energy balances.

**INTENDED AUDIENCE** : Undergraduate students in Chemical, Biochemical, and Environmental Engineering

**INDUSTRY SUPPORT** : Chemical and Petrochemical Process Industries such as BASF, Tata Chemicals, Reliance Industries, IFFCO, Dr. Reddy's, Haldia Petrochem, etc.

### **COURSE OUTLINE :**

This is an introductory fluid dynamics and heat transfer course that plays significant role in the chemical engineering as well in the biological, petroleum, and environmental engineering curriculum. It covers some important aspects of fluid flow and heat transfer along their commonality in various chemical engineering processes. The content of this course can be broadly classified into two topics: (1) fluid dynamics, and (2) heat transfer. The objective of this course is to learn the fundamental principles of fluid dynamics and heat transfer as well as to combine and apply the consolidated understanding to solve associated chemical engineering problems.

### **ABOUT INSTRUCTOR :**

Prof. Rabibrata Mukherjee is presently a Professor at the Department of Chemical Engineering at IIT Kharagpur. He obtained his PhD from IIT Kanpur in the year 2007. He joined IIT Kharagpur in the Department of Chemical Engineering as an Assistant Professor in 2009 and became a Professor in 2018. Prior to joining IIT Kharagpur, he was a Scientist at CSIR - Central Glass & Ceramic Research Institute, between 1997 and 2009. He is an internationally recognized expert in soft nano patterning and thin film instability, with specific emphasis on ordering and arranging objects by confined self organization at the nano and meso scale. So far he has published 85 international journals papers and holds 7 Indian patents. He has been awarded the CSIR Young Scientist Award in 2007, the MRSI Medal in 2014, and the SERB – STAR Award 2020. He is presently, the Chairman of DST funded Sophisticated Analytical and Technical Help Institute (SATHI) at IIT Kharagpur. He is an extremely popular teacher in IIT Kharagpur, where he teaches several core and elective courses both at the Under-graduate and the Post-graduate level.

Prof. Arnab Atta is presently an Associate Professor of Chemical Engineering at IIT Kharagpur. After receiving his bachelor and master of Chemical Engineering degrees from the Department of Chemical Engineering at Jadavpur University, Kolkata, he accomplished his Ph.D. in Chemical Engineering from IIT Delhi, New Delhi as a National Doctoral Fellow. Prior to joining IIT Kharagpur in 2013, he was a postdoctoral fellow in the Department of Mechanical Engineering at University of Alberta, Canada. His research interest is inclined toward developing computational models for a range of applications in multiphase flow and systems at different length scales.

### **COURSE PLAN :**

**Week 1:** Introduction to fluid dynamics: Properties of fluids and Kinematics

**Week 2:** Basic conservation equations: continuity and momentum

**Week 3:** Exact Solutions

**Week 4:** Order of Magnitude Analysis and Boundary Layer

**Week 5:** Boundary Layer Analysis

**Week 6:** Turbulent Flow, Reynold's Decomposition

**Week 7:** Fundamentals and mechanism of heat transfer: Conduction, Convection, and Radiation, Differential equations of heat transfer

**Week 8:** Steady-state conduction: Conduction in Cylinders and Spheres, Critical radius of insulation, Heat transfer from extended surface

**Week 9:** Transient conduction: Lumped system analysis, Numerical method for transient conduction analysis

**Week 10:** Forced convective heat transfer: Fundamentals, Boundary layers, Energy and momentum transfer analogies

**Week 11:** Natural convection: Mechanism, Empirical correlations for various surfaces Overview of boiling and condensation

**Week 12:** Radiation heat transfer: Introduction, properties, view factor