Advanced Numerical Methods for Coupled Particle-Laden Flow Problems

C. Fernandes[1]

[1]Transport Phenomena Research Center (CEFT), Department of Mechanical Engineering (DEMec), Faculty of Engineering at the University of Porto (FEUP), Rua Dr. Roberto Frias s/n. 4200-465 Porto, Portugal

Particle-laden flows are ubiquitous in numerous engineering and scientific disciplines, ranging from biomedical applications (e.g., drug delivery, blood flow modeling) to environmental and industrial processes (e.g., sediment transport, pollutant dispersion, fluidized beds). Simulating these complex multiphase flows presents significant challenges due to the intricate interactions between particles and carrier fluids, often involving coupling between fluid dynamics, particle transport, and interfacial phenomena. Accurate modeling of these coupled problems requires the development and application of sophisticated numerical methods that can effectively capture the multi-scale, non-linear behaviors of the systems.

This invited session aims to bring together leading researchers in the field of numerical methods for particle-laden flow simulations, with a focus on finite-volume, finite-element, finite-difference, meshless, and particle-based approaches. The session will cover both theoretical advances and practical implementations of these techniques across a wide range of applications. Topics of interest include, but are not limited to:

- Finite-volume and finite-element methods for resolving coupled fluid-particle interactions.
- Particle methods and meshless approaches for simulating high-fidelity particle transport.
- Hybrid numerical frameworks for multiphase flows combining various discretization techniques.
- Numerical challenges in simulating biomedical flows, such as blood-cell interactions and targeted drug delivery.
- High-performance computing strategies for large-scale simulations involving coupled problems.