XII International Conference on Coupled Problems in Science and Engineering, COUPLED 2027
June 27-30, 2027, Palma de Mallorca, Spain

HYBRID ARTIFICIAL INTELLIGENCE AND PHYSICS-BASED APPROACHES FOR COUPLED ENGINEERING SYSTEMS

C. FERNANDES*

* 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
cbpf@fe.up.pt

ABSTRACT

The proposed Invited Session addresses the emerging role of Artificial Intelligence and Machine Learning as enabling technologies for the modelling and solution of coupled engineering problems.

This session aims to provide a focused forum for the presentation and discussion of recent developments in data-driven and hybrid modelling techniques that enhance classical computational mechanics frameworks. The central objective is to explore how machine learning approaches can be systematically integrated with physics-based models to improve predictive accuracy, computational efficiency, and robustness in complex engineering systems. Particular emphasis will be placed on methodologies that respect underlying physical constraints while leveraging large datasets and advanced learning architectures.

The session will cover a broad spectrum of topics aligned with the conference scope, including: physics-informed machine learning for multiphysics simulations; data-driven model reduction and surrogate modelling; digital twins and real-time monitoring of coupled systems; uncertainty quantification and probabilistic learning in engineering analysis; reinforcement learning for control and optimization of coupled processes; and hybrid approaches combining numerical methods with artificial intelligence. Contributions addressing applications in structural mechanics, fluid–structure interaction, energy systems, materials engineering, and bioengineering are especially encouraged, reflecting the multidisciplinary nature of coupled problems.

By fostering interaction between experts in computational mechanics, applied mathematics, and artificial intelligence, this session seeks to identify new research directions and promote the development of scalable, interpretable, and reliable AI-enhanced computational tools. Ultimately, the session aims to contribute to the next generation of intelligent simulation frameworks capable of addressing the increasing complexity of real-world engineering systems.