

Numerical Methods for Engineering Innovation: From Digital Twins to Advanced Materials

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Abstract

This special session focuses on the development and application of robust numerical frameworks designed to solve complex engineering challenges, minimize physical testing costs, and provide deep insights into material behavior. As engineering systems become more intricate, the demand for high-fidelity simulations grows. This session highlights the critical role of numerical analysis in bridging the gap between raw experimental data and actionable engineering models. We emphasize the "back-calculation" of properties from advanced diagnostic techniques and the simulation of modern, non-traditional materials.

Key Topics for Submission:

- Virtual Prototyping & Digital Twins: Integration of real-time data with numerical models for predictive maintenance and system optimization.
- Advanced Material Characterization: Numerical approaches for analyzing porous media, additive manufacturing components, and complex multi-phase systems.
- Multi-Scale Modeling & Microstructure: Innovative simulations involving Micro-CT data, nanoindentation analysis, and the assessment of heterogeneous microstructures.
- Inverse Problems & Data Integration: Methods for back-calculating material constants and experimental parameters from complex physical tests.
- Discretization & Algorithmic Stability: New developments in FEA, CFD, and meshless methods tailored for high-precision engineering applications.

Session Goals

The objective of this session is to create a multidisciplinary forum where the emphasis is placed on the practical impact of numerical methods. We aim to showcase how advanced computational techniques can decode the complexities of modern materials and provide a "virtual laboratory" for the next generation of engineering design.