Special Session on

Physics-Guided and Domain-Informed AI for Electrical Machine Design and Fault Diagnosis

Organized and co-chaired by:

- **Anh Thanh Huynh**, University of Nottingham, UK anh.huynh@nottingham.ac.uk
- **Van Khang Huynh**, University of Agder, Norway huynh.khang@uia.no
- **Trung Duong**, ABB Corporate Research Center, Mannheim, Germany trung.duong@de.abb.com

Abstract

The design and analysis of electrical machines are increasingly shaped by data-driven models that accelerate development cycles and enable higher-performing, more sustainable systems. However, purely data-driven or black-box AI models often lack physical consistency, interpretability, and reliability, especially when data are scarce or when extrapolation is required. As a result, there is a growing interest in physics-guided and domain-informed AI approaches that incorporate finite-element analysis (FEA), analytical models, multiphysics constraints, or expert knowledge directly into learning algorithms. These hybrid paradigms allow AI models to leverage rich simulation data, adhere to known physical laws, improve generalization, and support robust optimization of machine geometry, materials, losses, and thermal behavior.

Meanwhile, data-driven methods are revolutionizing fault diagnosis and predictive maintenance. By integrating physics-based insights with historical and real-time data, hybrid AI models enable earlier fault detection, more accurate demagnetization and anomaly prediction, and better decision-making for machine health monitoring compared to traditional black-box approaches.

This special session welcomes contributions that advance physics-informed and domain-integrated AI for electrical machine design, analysis, optimization, and fault diagnosis.

Topics include AI-FEA fusion, digital twins, surrogate and reduced-order modeling, analytical-model-enhanced learning, multiphysics optimization workflows, hybrid

monitoring and diagnostic systems, interpretable ML, and methods to improve accuracy, reliability, and computational efficiency. Submissions with experimental validation, FEM-AI hybrid frameworks, and applications in transportation, renewable energy, and high-performance electric-drive systems are especially encouraged.

Topics of interest include, but are not limited to:

- Accelerated Design Optimization.
- Physics-Informed Neural Networks (PINNs).
- Surrogate Models.
- Prediction of Magnetic Losses, Thermal and Irreversible Demagnetization.
- AI-assisted Component Design.
- Predictive Maintenance.
- Enhanced Fault Detection.
- Digital Twins.
- Generative AI for Data Augmentation.
- Hybrid AI Models.

Important dates

- Full Paper Submission: February 1, 2026
- Full Paper Notification: May 1, 2026
- Final Paper Upload: June 1, 2026

Submission of papers

Paper submission follows the rules of regular papers. All the instructions for paper submission are included in the conference website:
https://icem2026.ubi.pt/submission.html