TUTORIAL 8

“Design, Modelling and Mathematical Formulations of PM-Free Special Machines: from Theory to Practice”

Sunday, May 18
3:30PM - 5:30PM
Room: Magnolia 3

SPEAKER

Doga Ceylan

Eindhoven Univ. of Tech.

SPEAKER

Joost van Zwieten

Eindhoven Univ. of Tech.

SPEAKER

Mitrofan Curti

Eindhoven Univ. of Tech.

This tutorial provides a comprehensive introduction to modeling and designing special permanent magnet-free (PM-free) electric machines using open-source numerical tools, taking the participants from the mathematical concepts up to computation of performance indicators of these machines.

We begin by exploring the motivations behind these machines, outlining their advantages and trade-offs compared to traditional permanent magnet designs. The fundamentals of magnetic field theory are introduced, covering Maxwell's equations, magnetostatics, material models, losses, and performance computation methods.

The tutorial then delves into the capabilities of Python-based numerical library Nutils, outlining its application in solving complex electromagnetic problems. Participants will learn how to formulate and solve magnetostatic problems, including simple airgap model to familiarize them with the library, and finally, a reluctance machine example will be used to demonstrate how the losses, and torque production, among other features, are computed. Hands-on exercises guide participants through implementing these concepts using example scripts, enabling them to visualize magnetic field distributions, calculate inductances, and compute torque profiles.

This tutorial equips attendees with the knowledge and practical skills necessary to design and analyze rare earth PM-free electric machines effectively, leveraging the power of open-source tools, giving insights on the backbones functionality of numerical tools.

BIOS

“Design, Modelling and Mathematical Formulations of PM-Free Special Machines: from Theory to Practice”

SPEAKER

Doga Ceylan

Eindhoven Univ. of Tech.

SPEAKER

Joost van Zwieten

Eindhoven Univ. of Tech.

SPEAKER

Mitrofan Curti

Eindhoven Univ. of Tech.

Doga Ceylan received the B.Sc. and M.Sc. degrees from the Department of Electrical and Electronics Engineering, Middle East Technical University (METU), Ankara, Turkey, in 2016 and 2018, respectively, where he worked on multi-physical modeling of electromagnetic launchers and capacitive pulsed-power sources. He obtained his Ph.D. with cum laude from the Electrical Engineering Department of Eindhoven University of Technology (TU/e), in the Netherlands, in 2023. During his Ph.D. within the Electromechanics and Power Electronics (EPE) research group, he worked on the design and control of various types of reluctance machines for heavy-duty applications. He developed several analytical, numerical, and semi-analytical simulation models for nonlinear magnetodynamic problems, including laminated electrical steel. After his Ph.D., he was a Postdoc researcher at TU/e working on the development of a demonstrator prototype of a high-torque variable flux reluctance motor designed for agricultural electric tractors. He is currently an assistant professor at TU/e and continues his research on the multi-physical design of electromechanical systems, focusing on electric mobility and the development of novel control strategies applied to reluctance-based electrical drive systems.

Joost van Zwieten has a bachelor's degree in Electrical Engineering and a master's degree in Numerical Mathematics, both from Delft University of Technology. He started, but did not finish, a Ph.D. research project at the same university on Discontinuous Galerkin Finite Element discretization techniques of 1D multiphase pipe flow models. After leaving the university he joined the small consultancy company Evalf, whose main business is developing the open source Finite Element library Nutils.

Mitrofan CurtiCurti obtained his B.Sc.-degree in 2011 at Technical University of Moldova, M.Sc.-degree at Warsaw University of Technology in 2014. Mitrofan successfully defended his PhD in 2019 at the Technical University of Eindhoven. The research is focused on the analysis of the advantages and limitations of higher-order spectral elements applied to models of the electrical machines. Currently Mitrofan is an assistant professor in the field of electromechanical systems (EMS) in the group of Electromechanics and Power Electronics at TUE. In his team of over 6 PhD students, Mitrofan is involved in projects concerning magnetic material, insulation, and eddy currents characterization, in linear actuators an electric machines. His research is focused on combining efficient numerical schemes to model the material behavior exposed to extreme working conditions such as high frequency, voltage, and currents. In addition, Mitrofan is teaching a course on advanced actuators design where he covers design and modelling strategies in special actuators.