ICEM 2024, Torino, September 1-4 2024

Tutorial Proposal

TUTORIAL TITLE:

Advancements in digital design of rare earth free electric traction motors

TUTORIAL PRESENTERS (Full Names, affiliation, and e-mail addresses):

Mircea Popescu, Ansys Inc, mircea.popescu@ansys.com

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BIOS OF THE PRESENTERS (150 words each):

Mircea Popescu (M-'98, SM-'04, F'15) is Principal Product Specialist with Ansys UK. He received the M.Eng. and Ph.D. degrees in electrical engineering from the "Politehnica" University of Bucharest, Romania, and the D.Sc.(Tech) degree in electrical machines from Aalto University, Espoo, Finland. He has 40 years of experience in research & development and academic teaching focused on electrical machines and drives. Earlier in his career, he was with National Research Institute for Electrical Engineering, Bucharest, Romania, Helsinki University of Technology (now Aalto University), Finland, SPEED Lab at University of Glasgow, U.K. and Motor Design Ltd, U.K.

Matteo Carbonieri received the M.Sc. and Ph.D degrees in electrical engineering from the University of Padova, Padova, Italy, in 2017 and 2021 respectively. He is currently a senior electrical machine design engineer at Ansys Inc. His research mainly focus is on synchronous and induction machine design and analysis.

ABSTRACT (200 - 300 words):

Electric traction/propulsion is widely seen one of the main solutions to improve energy efficiency and reduce CO2 emissions in transportation. Whether hybrid or full electric future propulsion systems will undoubtedly require power electronic driven electrical machines. Industry-led technology road maps across automotive, aerospace, heavy goods transport etc. sectors recognise the importance of electrification and have set demanding targets on future electrical machine power to weight, efficiency and cost, alongside considerations of security of material supply chain and local manufacturing capabilities.

There is a strong interest to reduce the volume and cost of active materials in propulsion motor technologies beyond their current state-of-art. Potential solutions include increased motor speeds and higher pole numbers and/or typologies such as

synchronous reluctance, electrically excited and induction machines with reduced dependence on rare-earth materials. As there can be significantly different usage and performance requirements across e-mobility applications adopting a common standard of motor design is unlikely to yield the optimum in terms of overall system energy efficiency and cost. Design software needs to become increasingly sophisticated to cater for the new technological development and in providing a valuable experience for potentially non-specialist users. These considerations will be discussed and compared.

In particular the tutorial will explore the prospects of advancements in new computational intelligence in addressing the challenges of an increasingly digital design environment. Automotive and aerospace case studies covering a range of new developments will be outlined.

A combined cutting-edge sensitivity analysis with multi-objective optimisation techniques can be applied in the design of an electric propulsion motor. The accessibility of a high performance or cloud computing infrastructure is capable of delivering a truly revolutionary design workflow, allowing multiple candidate solutions to be evaluated in terms of electromagnetic, thermal and mechanical behaviour across the full operating envelope.

The tutorial is mainly aimed at Engineers and Technical Professionals who have an interest in electric machines design and future technology trends. The tutorial would also be of benefit to postgraduates embarking on a PhD program.

List of contents:

- Innovations in multi-objective optimization and cloud based computing of E-Motors, including future trends
- Advanced computation methods for E-Motors: engineering and physics based algorithms
- Design case study #1: electrically excited synchronous traction machine
- Design case study #2: induction traction machine