

Tutorial proposal form ECCE 2014

1. Title of Tutorial:

Electromechanical Power Loss Analysis in Design and Optimisation of Electrical Machines: Practical Aspects of Accurate Loss Estimation and Mitigation Techniques

2. Abstract: (500 word limit, If the tutorial is accepted, this abstract will be published in the conference web page, program, and proceedings)

Continuous drive towards high-power density and high-efficiency machine designs has resulted in increased interest in more accurate design and optimisation methodologies, where the multi-disciplinary and multi-physics phenomena are accounted for. In depth understanding of the electromagnetic, thermal and mechanical interactions is essential when developing new machine designs or evaluating existing solutions. The electromechanical power loss is of particular interest as it determines the power output capability and power conversion efficiency of an electrical machine. The theoretical analysis of the power loss allows for identifying and quantifying the loss mechanisms that would be difficult to determine if a common testing procedure on complete machine hardware was used instead. It is important to note that the power loss and thermal effects are strongly interdependent and their accurate derivation requires a careful consideration. Importance of this research theme has been acknowledged by numerous authors and documented by the wide body of work devoted to the high-performance electrical machines and many others. The most commonly reported industrial applications are focused, but not limited to the 'More Electric Aircraft', 'Hybrid Vehicle' and 'Electrical Vehicle' concepts.

The aim of this tutorial is to outline and overview various power loss mechanisms generated in electrical machines under normal operation. Particular emphasis is placed on methods of predicting and mitigating the loss. Various practical examples from the instructors experience are given in detail including both theoretical and experimental techniques and methodologies. The loss mechanisms discussed in the tutorial include: mechanical loss, winding loss, core loss, permanent magnet loss and retaining sleeve loss. More specifically, the latest developments in timely topics such as proximity loss in windings, core loss in electric motors within variable speed systems, loss in high-energy permanent magnets (NdFeB and SmCo), loss in stator and rotor retaining sleeves (carbon fibre), mechanical and bearings loss are discussed. Some details regarding loss thermal dependence at high-frequency AC operation is also provided.

3. Outline of tutorial

The topics are structured as follows:

- (I) Winding AC losses in high frequency electrical machines
- (II) Core losses in electrical machines with non-sinusoidal supply
- (III) Magnets and retaining sleeves losses
- (IV) Mechanical and bearings losses

The tutorial is mainly addressed to engineers from traction and aerospace industry, but is also useful to researchers working in other fields and to electrical engineering students.

4. Lead Instructors:

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5. Other Instructors (Name / Affiliation & contact information)

N/A

6. Instructor Bios: ~150 words each (Please provide a brief biography of each instructor, describing the qualifications for presenting the proposed tutorial, including the work and publications that are most relevant to the proposal)

Dr. Rafa Wrobel received the M.Sc. Eng. degree from the Technical University of Opole, Poland, and the Ph.D. degree from the Technical University of Lodz, Poland, in 1998 and 2000 respectively. From 2001 he was with the Technical University of Opole as an Assistant Professor. In 2002, he joined the University of Bristol, UK, as a Research Fellow. Currently, Dr. Wrobel is a Senior Research Fellow within the Electrical Energy Management Group at University of Bristol, UK. Dr. Wrobel published over 140 papers in conferences and peer-reviewed journals. He is a senior member of IEEE and associated editor for the IEEE IAS. Dr. Wrobel research interests include the design and optimisation of electrical machines in application to 'More Electric Aircraft' and 'Hybrid Vehicle' concepts. These include development and application of the design and optimisation techniques accounting for the multi-physics phenomena.

Dr. Mircea Popescu (M'98, SM'04) received the MEng and PhD in electrical engineering from University "Politehnica" Bucharest, Romania and the Doctor of Science degree from Helsinki University of Technology, Finland. Within his 30 years of engineering profession, Dr. Popescu was with the Research Institute for Electrical Machines, Bucharest, Romania, Helsinki University of Technology, Finland and University of Glasgow, U.K. Since 2008, Dr. Popescu is the Engineering Manager and Chief Design Officer of Motor Design Ltd., U.K, leading R&D projects on electrical machines and drives for power traction applications, including hybrid/electrical vehicles, and formula-e racing cars. Dr. Popescu published over 100 papers in conferences and peer-reviewed journals. He is the recipient of the first prize, best paper award from IEEE IAS EMC in 2002, 2006, 2008. Dr. Popescu is the Chair of IEEE IAS Electrical Machines Committee, Technical Committee Paper Review Chair for IEEE TRANSACTIONS ON INDUSTRY APPLICATIONS and IEEE IAS Distinguished Lecturer for 2014-2015.

Literature references

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